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SOIL SURVEY

Polk County Iowa

UNITED STATES DEPARTMENT OF AGRICULTURE

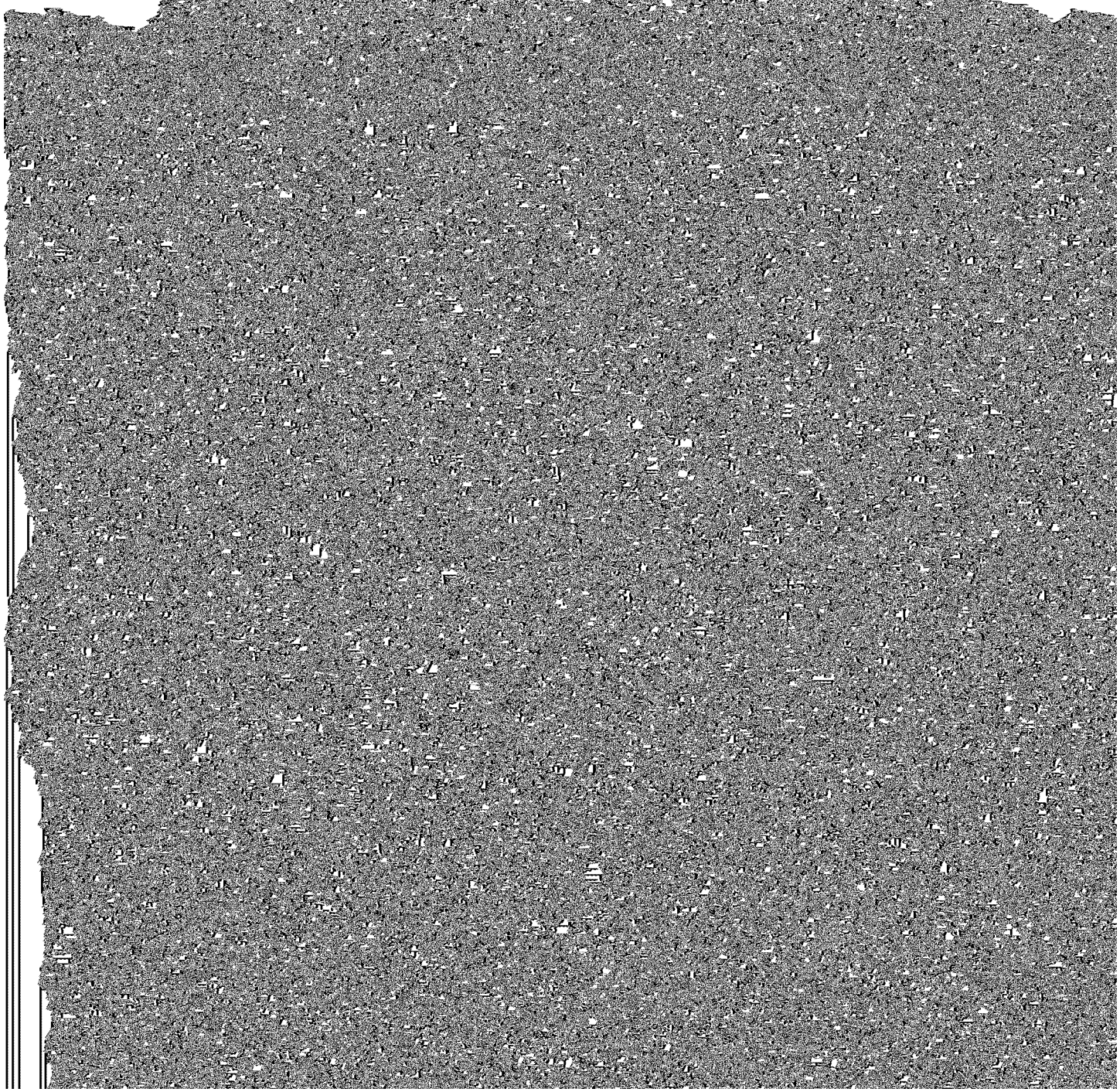
Soil Conservation Service

In cooperation with

IOWA AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

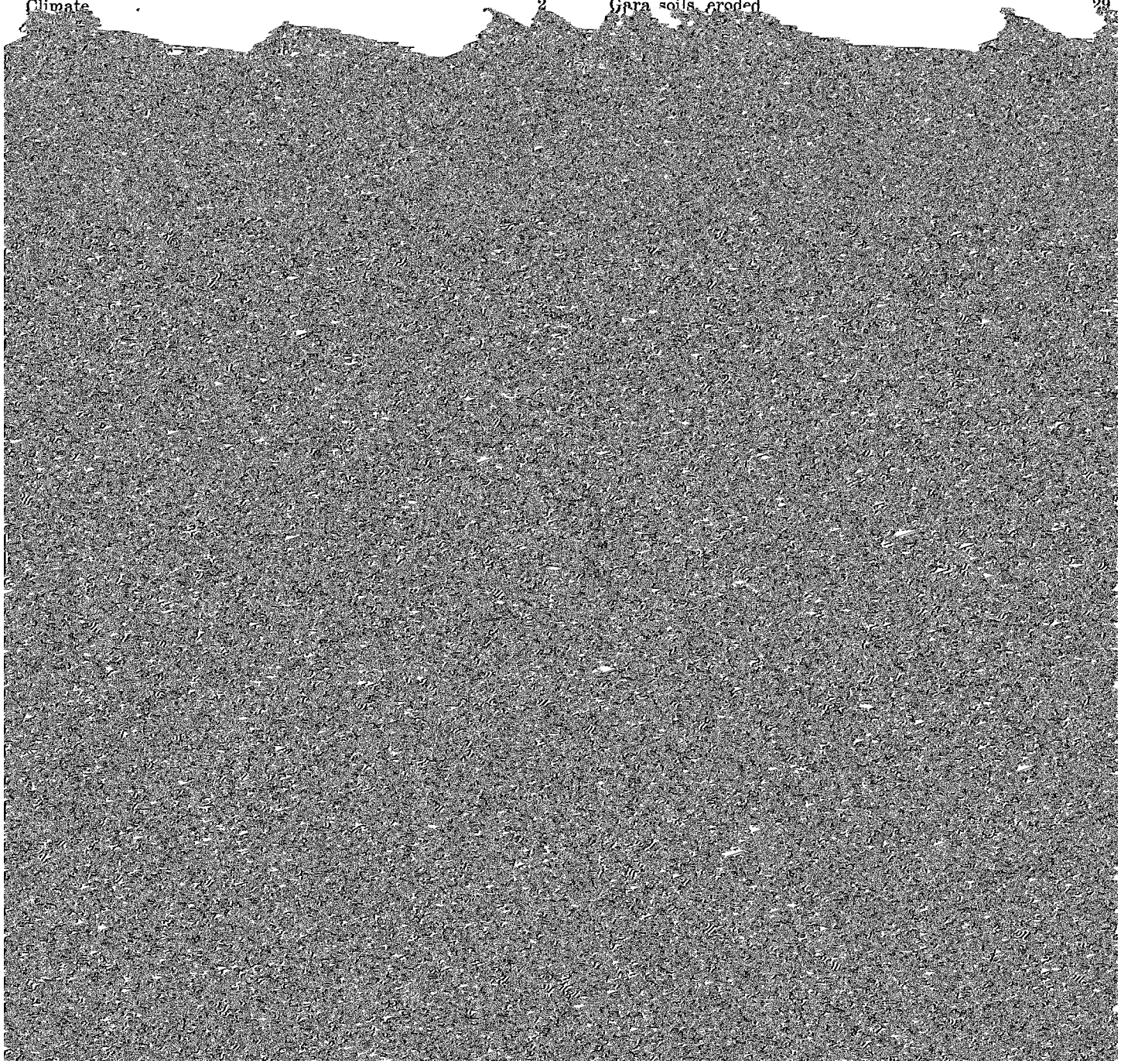
THIS SURVEY of Polk County was made to help you plan the kind of farming that will protect your soils and



type, and of Clarion loam, 5 to 9 percent slopes, moderately eroded.

After you have read the description

CONTENTS



SOIL SURVEY OF POLK COUNTY, IOWA

REPORT BY R. J. McCRACKEN, SOIL CONSERVATION SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

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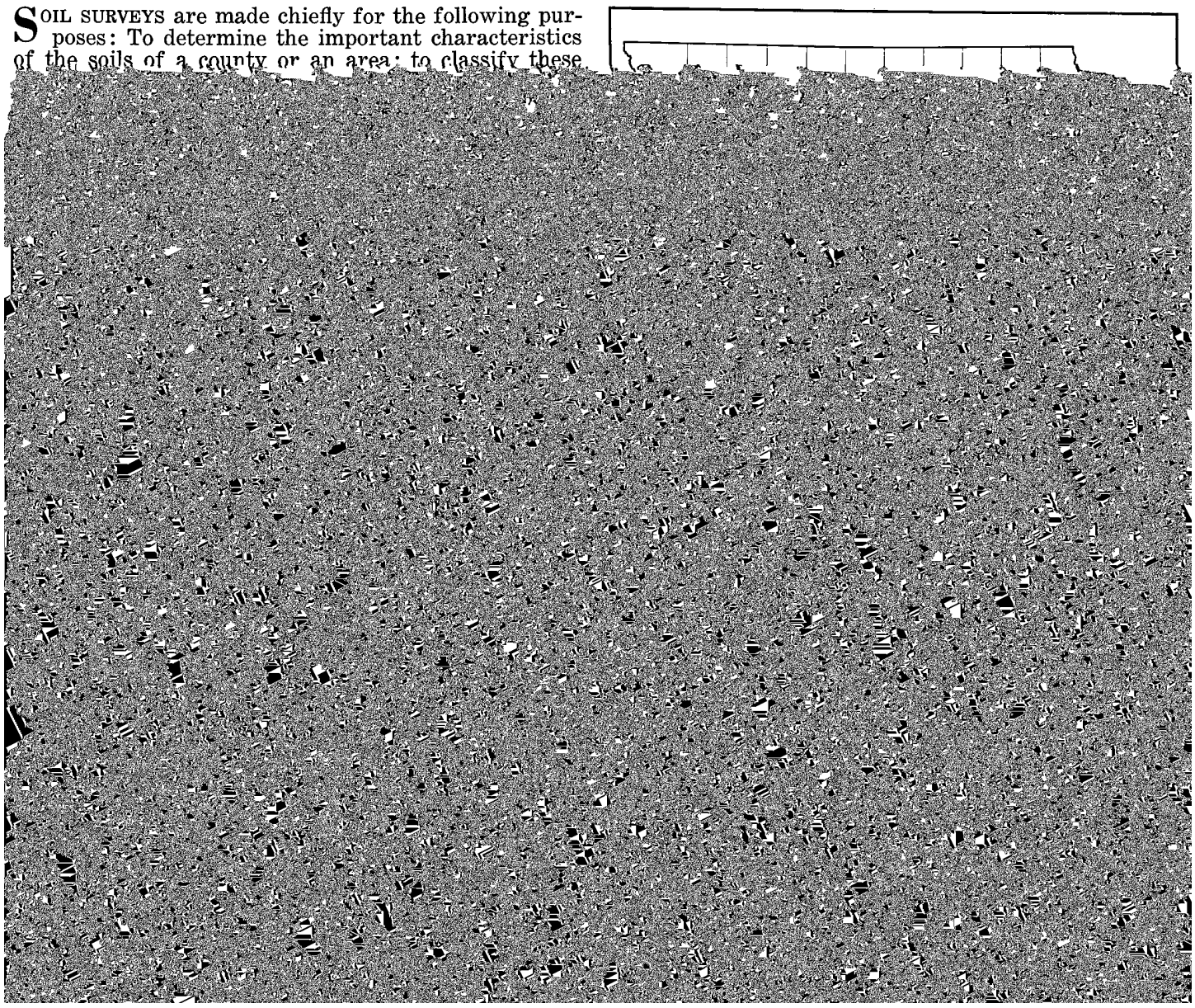
UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH IOWA AGRICULTURAL EXPERIMENT STATION

SOIL SURVEYS are made chiefly for the following purposes: To determine the important characteristics of the soils of a county or an area; to classify these



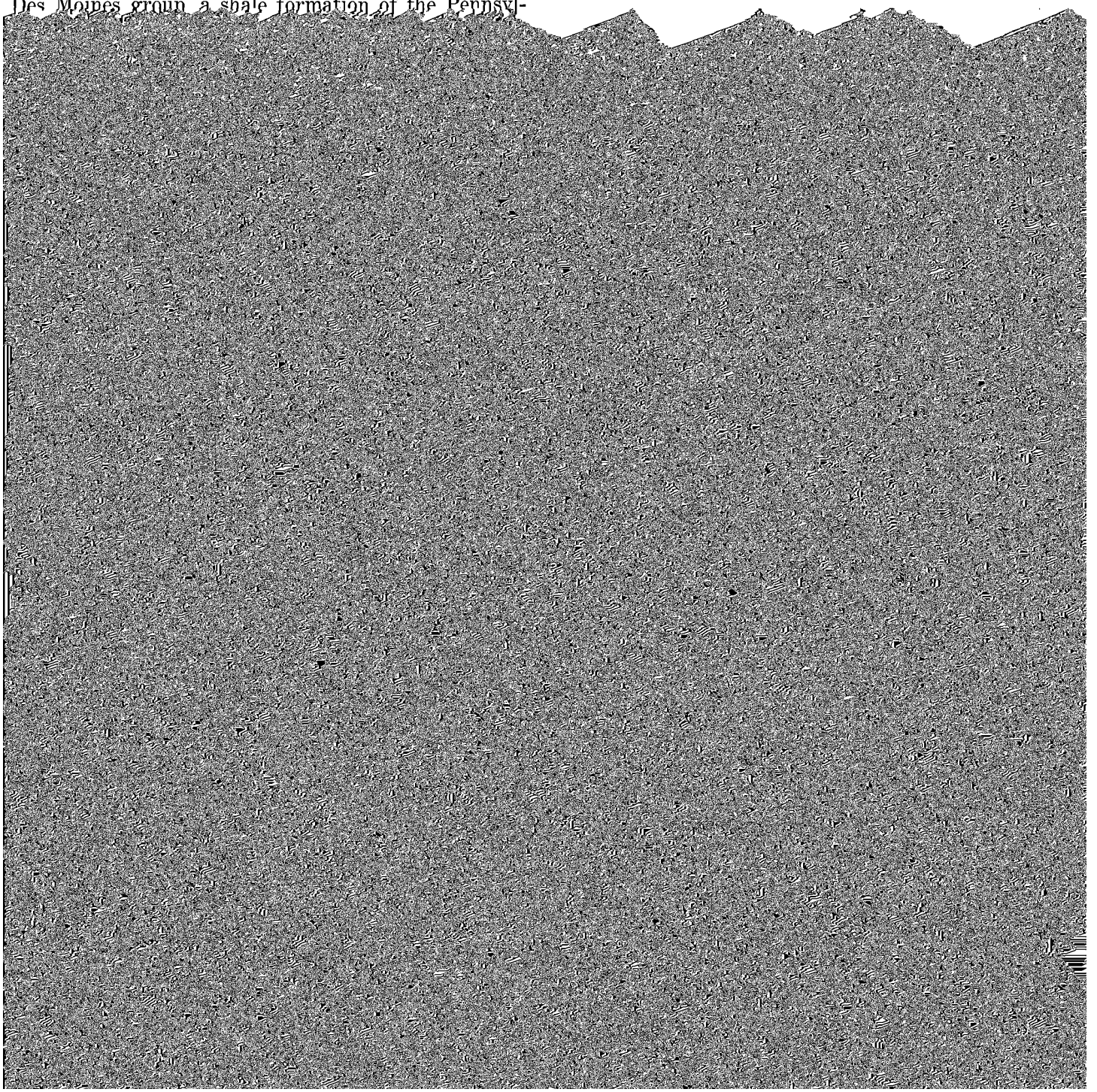
In contrast, the glacial material contains many sand and gravel particles and some large boulders.

Alluvial materials are found in general soil area 3. These are water-deposited materials that range from gravel to silty clay in texture. Some of the material was glacial outwash deposited as the glacial ice was melting. In other areas the material was deposited by overflowing streams.

The entire county is underlain by bedrock of the Des Moines group, a shale formation of the Pennsyl-

along the major streams, particularly along the Des Moines River. As shown in figure 2, the area originally covered by prairie grasses was much greater than that covered by trees.

The native grasses contributed to the development of dark-colored, fertile soils that are fairly high in organic matter. The native trees contributed to the development of light-colored soils that are less fertile and contain less organic matter.



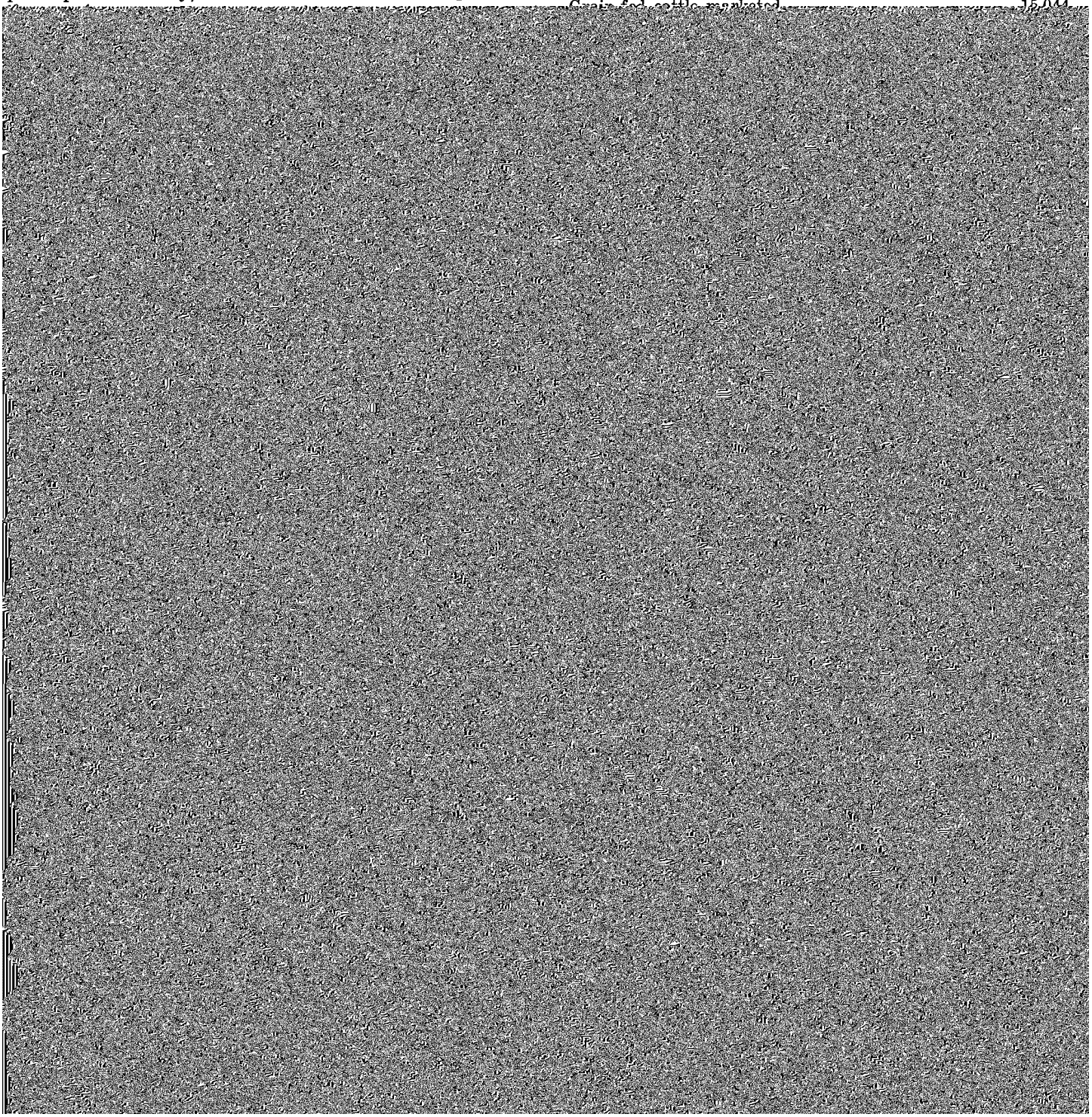
Drainage

The county is drained by the Des Moines River and its tributaries and by the Skunk River. These rivers flow across the county in a southeasterly direction. The Raccoon River is one of the principal tributaries of the Des Moines River. It enters the county near the southwestern corner and, with Walnut Creek, its principal tributary, drains the southwestern part of

percent, or 182,159 acres, was rented by the operators. Lots, roads, buildings, woods, and wasteland totaled 25,098 acres.

Dairy cattle, beef cattle, and poultry are the livestock most extensively raised in Polk County. The number of livestock in the county in 1955 was as follows (*6*) :

	Number
Grain-fed cattle marketed	15,044



are next in importance. Nineteen percent of the cropland was used for soybeans, and 19 percent for oats. Hay ranks next in acreage of harvested crops. About 10 percent of the land in farms is used for hay. The chief hay crops are alfalfa, red clover, bromegrass, and timothy, or mixtures of these grasses and legumes. The acreages of various crops grown in Polk County in 1955 were as follows (*6*):

	Acres
Corn for all purposes	103,730
Oats, threshed or combined	42,507
Soybeans for all purposes	42,204
Wheat, barley, and rye	960
Hay (total)	31,319
Clover, timothy, and mixtures of clover and grasses	15,404
Alfalfa and alfalfa mixtures	15,417
Other (all tame and wild hay not otherwise enumerated)	498
Pasture	67,696
Other crops	1,485

In 1956 there were more tractors than farms in the county. The number of heavy farm machines in the county on January 1, 1956, was as follows:

	Number
Tractors	2,904
Grain combines	893
Cornpickers	1,033
Pickup haybalers	281
Motortrucks	785

Soil Survey Methods and Definitions

The scientist who makes a soil survey examines soils in the field, classifies the soils in accordance with facts that he observes, and maps their boundaries on an aerial photograph or other map.

FIELD STUDY.—The soil surveyor examines road cuts, bores into the soil with an auger, or digs holes with a spade. The places examined are not spaced in a regular pattern but are located according to the lay of the land. Usually they are not more than a few hundred feet apart. Each soil area outlined on the map has been examined. Many borings are made in complex areas. In most soils, the holes or borings reveal several distinct soil layers, called horizons, which collectively are termed the soil profile (fig. 5). The color, texture, consistence, and porosity of each layer are observed, and their content of stones and gravel is noted. The reaction (or degree of acidity) and the presence of free lime or salts are determined by simple tests. Other factors considered are drainage, both internal (through the soil) and external (over the soil); permeability, or the rate at which water moves through the soil; moisture-holding capacity; topography; and the interrelation between soil and vegetation.

Color of the topmost layer is usually related to the amount of organic matter. The darkest soils are usually those that have the highest content of organic matter and nitrogen. Gray and olive colors in the lower layers, or streaks and spots of gray and yellow, called mottles, commonly indicate poor drainage and poor aeration. Uniform brown to yellowish-brown colors indicate good drainage and aeration.

Texture, or the content of sand, silt, and clay, is determined by the proportion of the different sizes of particles that make up the soil. The largest particles are sand; they feel gritty between the fingers. Silt particles are smaller than sand and feel smooth and floury. Clay particles are the smallest; they can be seen only with electron microscopes. Soils that are high in clay feel dense and sticky. The soil scientist judges the texture by the feel of the soil when rubbed between his thumb and forefinger. Frequently, the texture is verified in the laboratory by mechanical analyses.

Some of the terms used to describe texture are silt loam, loam, clay loam, sandy loam, loamy sand, or clay. Loam is about 20 percent clay, about 40 percent silt, and about 40 percent sand. Silt loam has much less sand and more silt. It is about 15 percent clay, about 20 percent sand, and at least 50 percent silt. Clay loam consists of about equal proportions of sand, silt, and clay but may contain up to 40 percent clay and up to 80 percent silt and clay. Sandy loam, loamy sand, and sand have increasing percentages of sand, in that order. Clay is more than 40 percent clay-sized particles.

Texture affects the quantity of moisture the soil will hold available to plants; the permeability, or rate at which air and water move through the soil; and the ease with which the soil can be cultivated. Because of these considerations, silt loam and loam are the most desirable soil textures. Clay restricts the movement of air and water and is difficult to work. Sandy soils do not have good water-holding capacity and may be droughty.

A soil is called "stony" or "gravelly" only if there are enough stones or gravel in the surface layer to interfere with cultivation.

Consistence, or the tendency of the soil to crumble or to stick together, indicates whether it is easy or difficult to keep the soil open and porous under cultivation. Terms used to describe the consistence of moist soil are loose, very friable, friable, slightly firm, firm, very firm, and extremely firm. Friable and slightly firm are the most desirable forms of consistence. The firmer the soil, the more difficult it is to work. Sandy soils are usually loose.

Porosity is the term used to indicate the relative volume of the soil that is occupied by pores, or air spaces. We refer to a soil as porous if a large proportion of the total volume consists of coarse pores.

Vegetation affects the color and other characteristics of soils. Soils that formed under grass usually have a thicker and darker colored surface layer than soils that formed under trees, if other conditions are the same. Soils that formed under trees usually are more acid than those that formed under grass. The dark surface layer is thinner than that of grassland soils. Some soils formed under a mixture of grass and trees and are intermediate in properties between the grassland and the forest soils.

Permeability is the quality of the soil that enables it to transmit water or air. It can be measured quantitatively in terms of rate of flow. The relative classes of soil permeability are rapid, moderate, and slow.

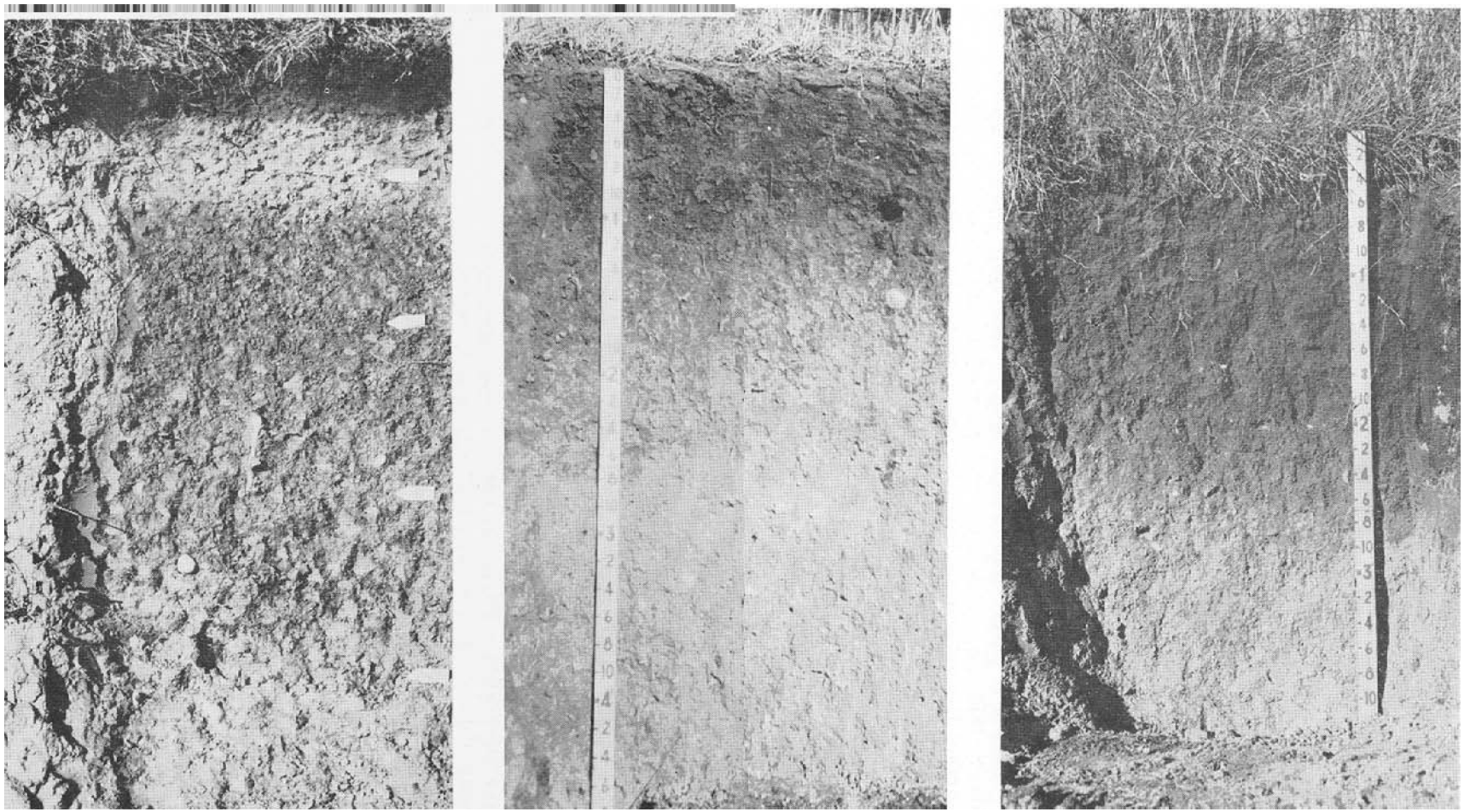
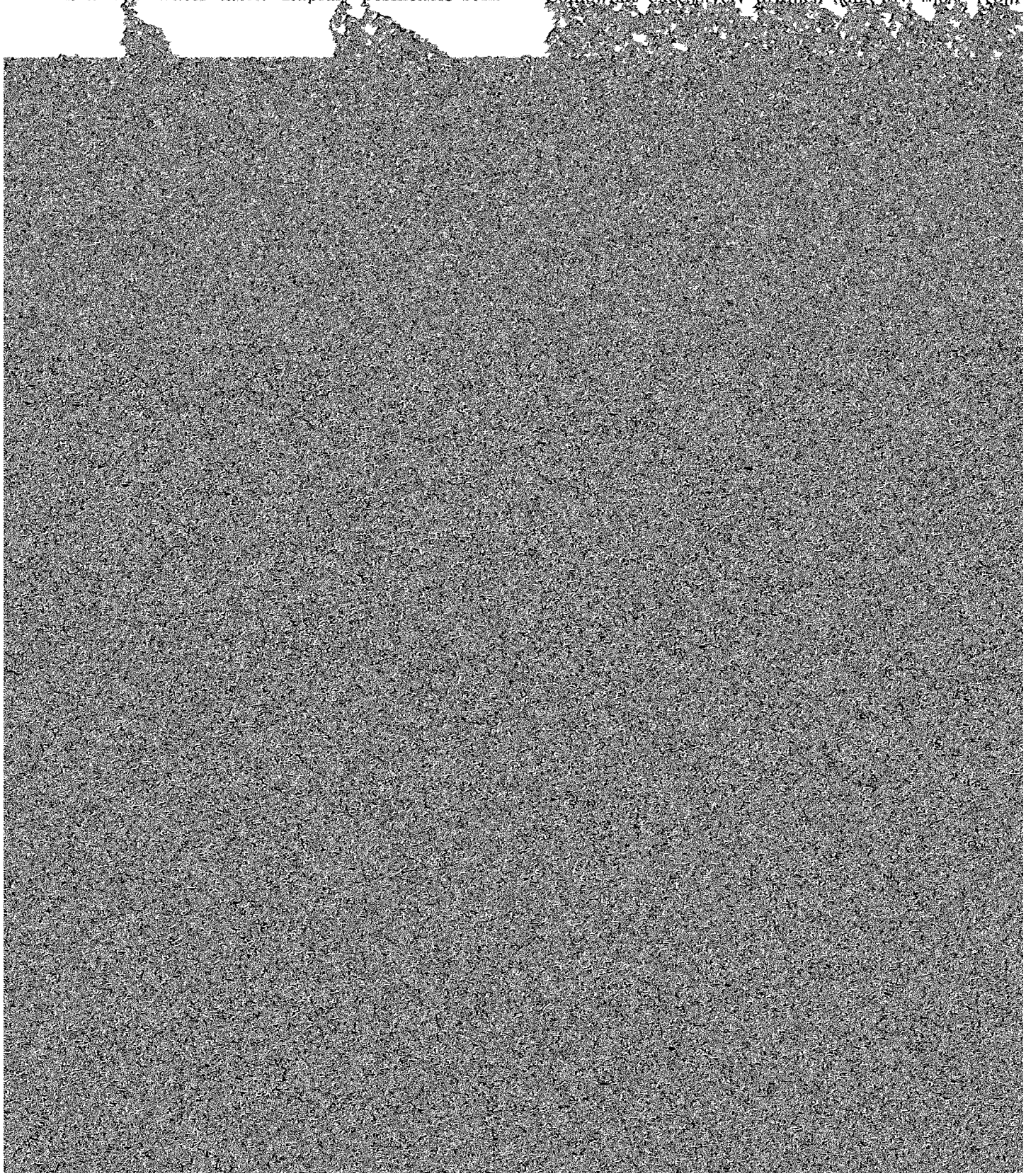


Figure 5.—**Profiles of Hayden loam (left), Clarion loam (center), and Webster silty clay loam (right). The Webster soil is poorly drained and has a thick, dark-colored surface layer. Clarion loam is well drained and has a surface layer that is thinner than that of Webster silty clay loam and thicker than that of Hayden loam. Hayden loam has a thin surface layer and a lighter colored subsurface layer, or A_2 horizon. Hayden loam formed under forest. Clarion loam and Webster silty clay loam formed under prairie.**

Moderate permeability is the most desirable because it permits free movement of air and water, unless the soil has a high water table. Rapidly permeable soils

ficial drainage is not needed. The Tama, Clarion, Hayden, and Fayette soils are well drained.

Somewhat excessively drained soils are those from



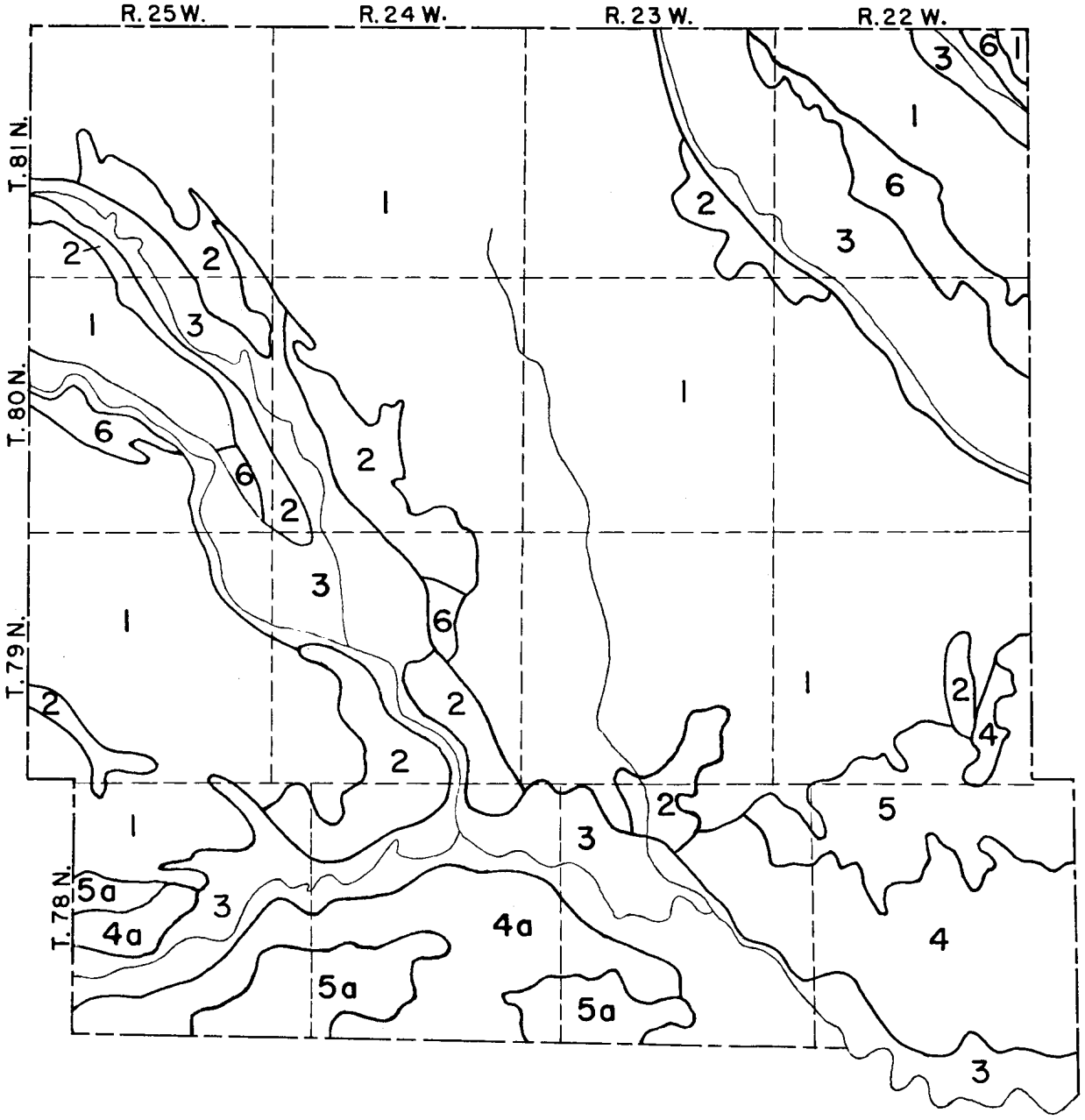


Figure 6.—General soil areas of Polk County.

1. Level to gently sloping, dark-colored soils formed from glacial till: chiefly Clarion, Nicollet, and Webster soils.

2. Gently sloping to steep, light colored to moderately dark colored soils formed from glacial till: chiefly Hayden and Lester soils.

3. Nearly level soils formed from outwash and alluvium: chiefly Colo, Waukegan, Dickinson, and Dorchester soils.

4. Gently sloping to steep, light colored to moderately dark colored soils formed from loess: chiefly Fayette and Downs soils.

4a. Gently sloping to steep, light colored to moderately dark colored soils formed from loess or till: chiefly Ladoga and Lindley soils.

5. Nearly level to moderately sloping, dark-colored soils formed from loess: chiefly Tama and Muscatine soils.

5a. Nearly level to moderately sloping, dark-colored soils formed from loess and till: chiefly Sharpsburg and Shelby soils.

6. Gently sloping to steep, sandy soils: chiefly Hagener, Farrar, and Chelsea soils.

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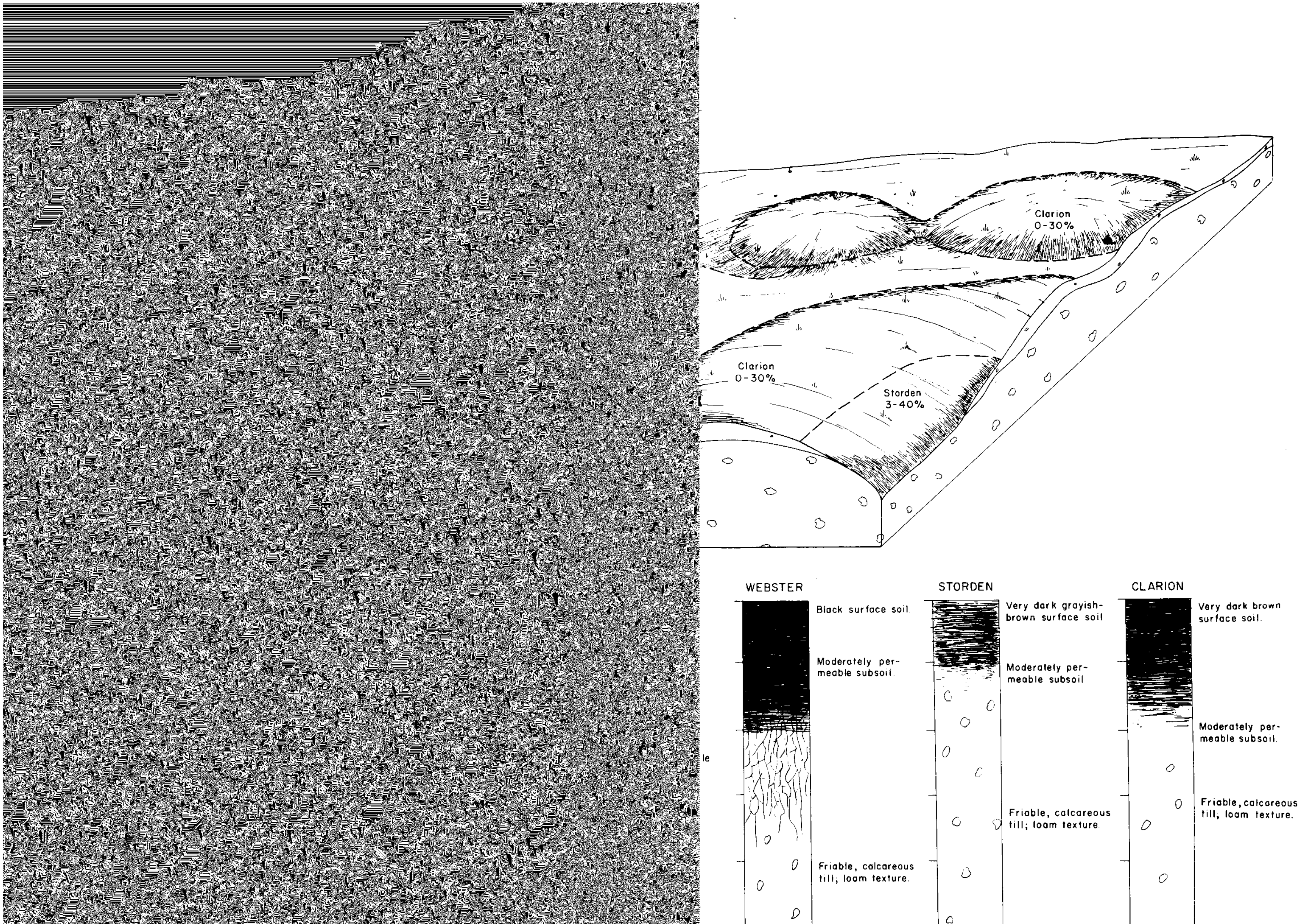
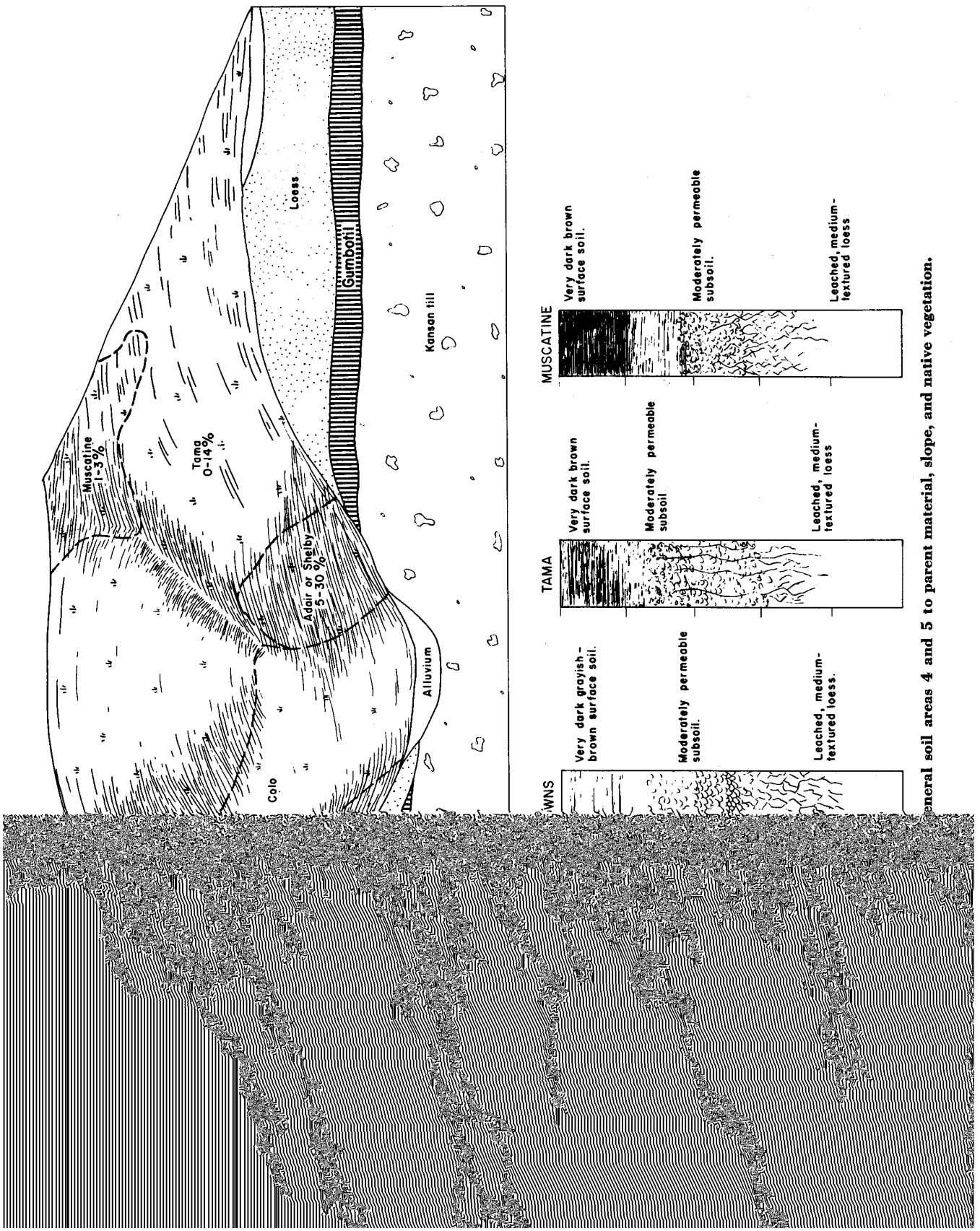
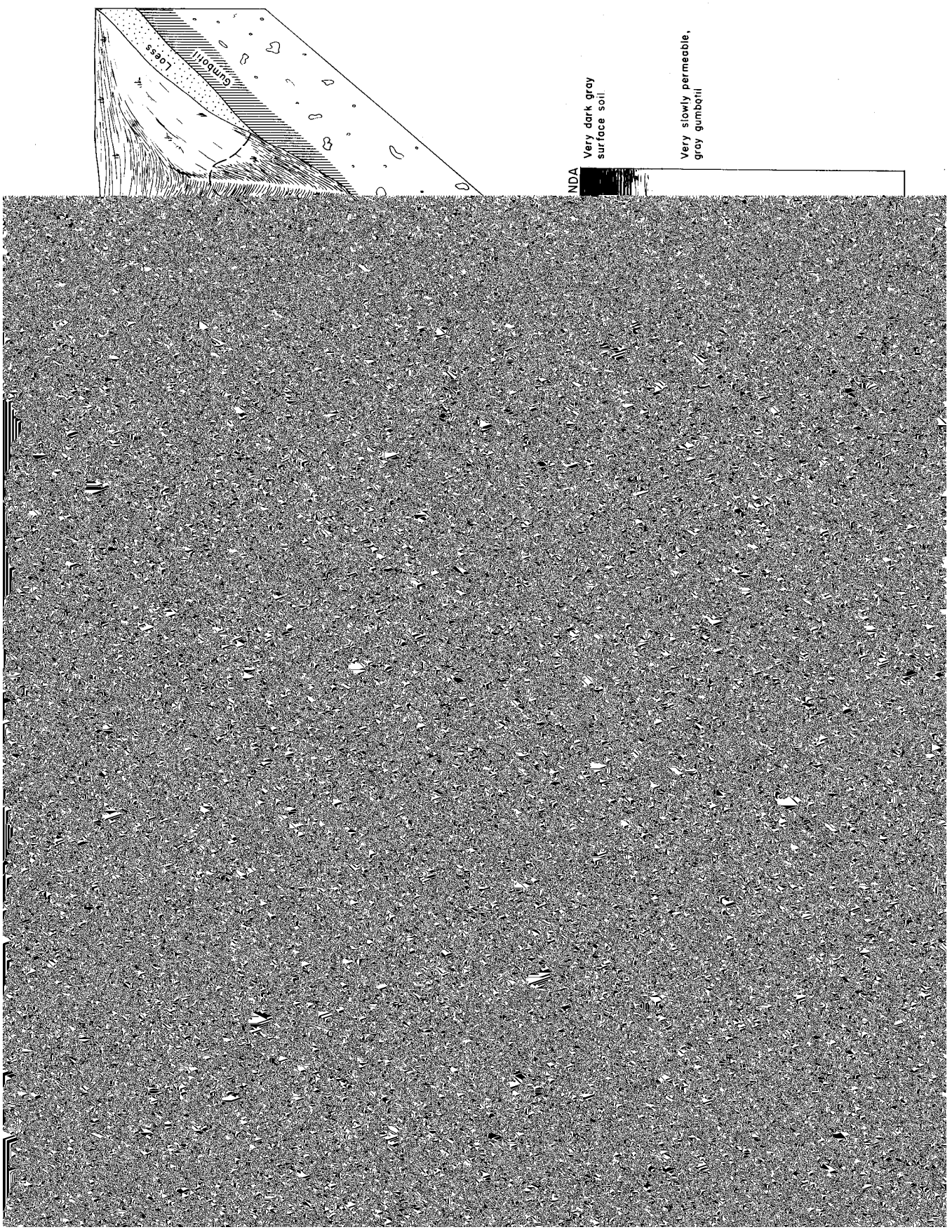


...rent material, slope, and native vegetation.



neral soil areas 4 and 5 to parent material, slope, and native vegetation.


Loess
Gumbotil
NDA
Very dark gray surface soil
Very slowly permeable, gray gumbotil

tionship of these soils to parent material, slope, and native vegetation.

Area 2.—This area is much less extensive than area

Adair series

The Adair soils have a long and complex history. They developed from Kansan glacial till. Many thou-

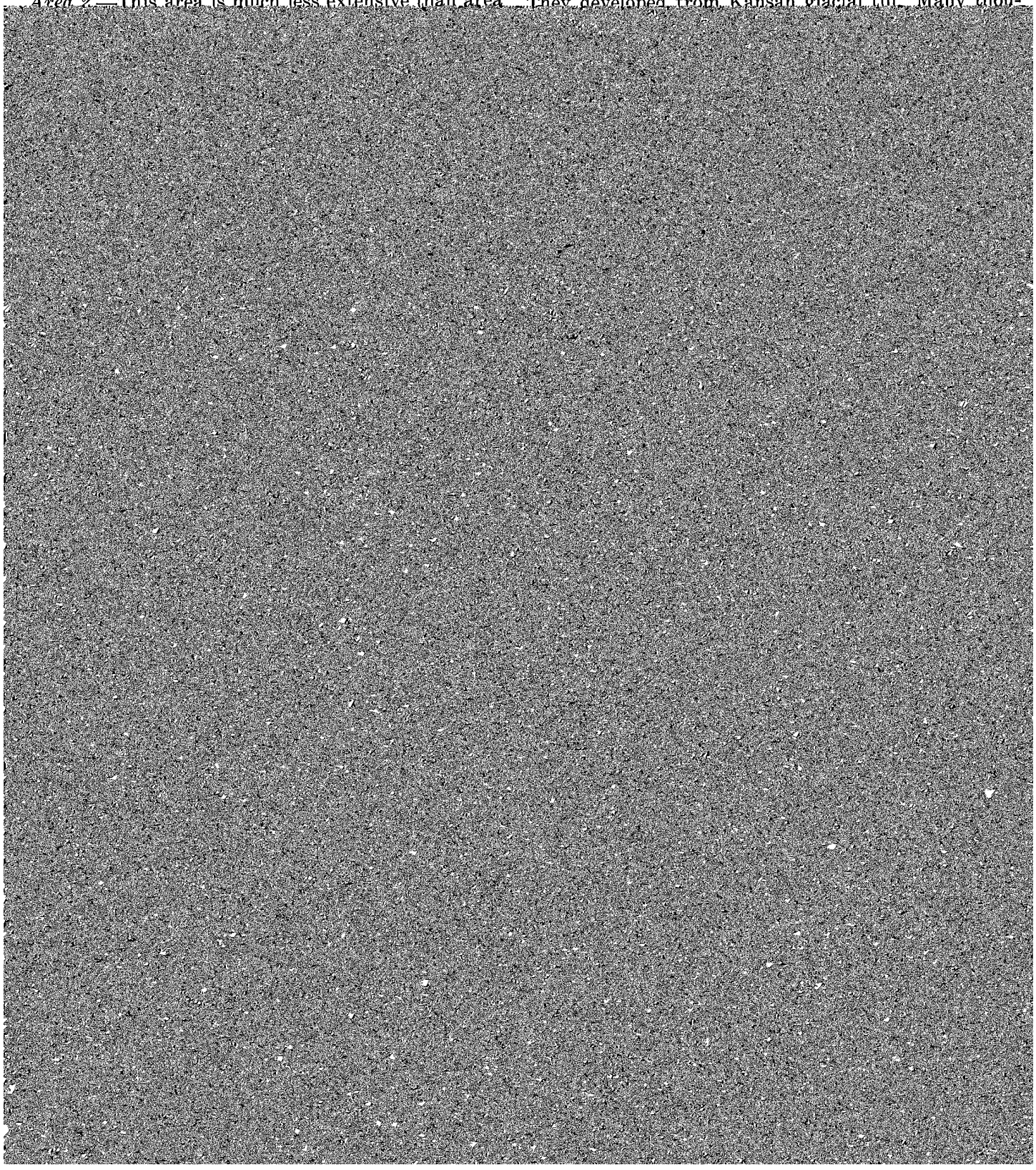


TABLE 2.—*Approximate acreage and proportionate extent of soils mapped*

Soil	Acres	Percent	Soil	Acres	Percent
Adair clay loam, 5 to 9 percent slopes	27	(1)	Clarion silt loam, 14 to 20 percent slopes, moderately eroded	2	(1)
Adair clay loam, 5 to 9 percent slopes, moderately eroded	48	(1)	Clearfield silty clay loam, 5 to 9 percent slopes	6	(1)
Adair clay loam, 9 to 14 percent slopes, moderately eroded	111	(1)	Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded	3	(1)
Adair soils, 5 to 9 percent slopes, severely eroded	3	(1)	Clearfield silty clay loam, 9 to 14 percent slopes, moderately eroded	10	(1)
Adair soils, 9 to 14 percent slopes, severely eroded	4	(1)	Colo silty clay loam	9,846	2.6
Alluvial land	6,628	1.7	Colo silty clay loam, channeled	76	(1)
Ames loam	53	(1)	Colo loam, loamy subsoil variant	3,631	1.0
Ankeny sandy loam, 0 to 2 percent slopes	401	.1	Colo-Judson-Nodaway complex	527	.1
Ankeny sandy loam, 2 to 5 percent slopes	482	.1	Colo-Terril complex, 0 to 2 percent slopes	4,620	1.2
Atterberry silt loam, 1 to 3 percent slopes	514	.1	Colo-Terril complex, 2 to 5 percent slopes	1,918	.5
Atterberry silt loam, bench position, 1 to 3					

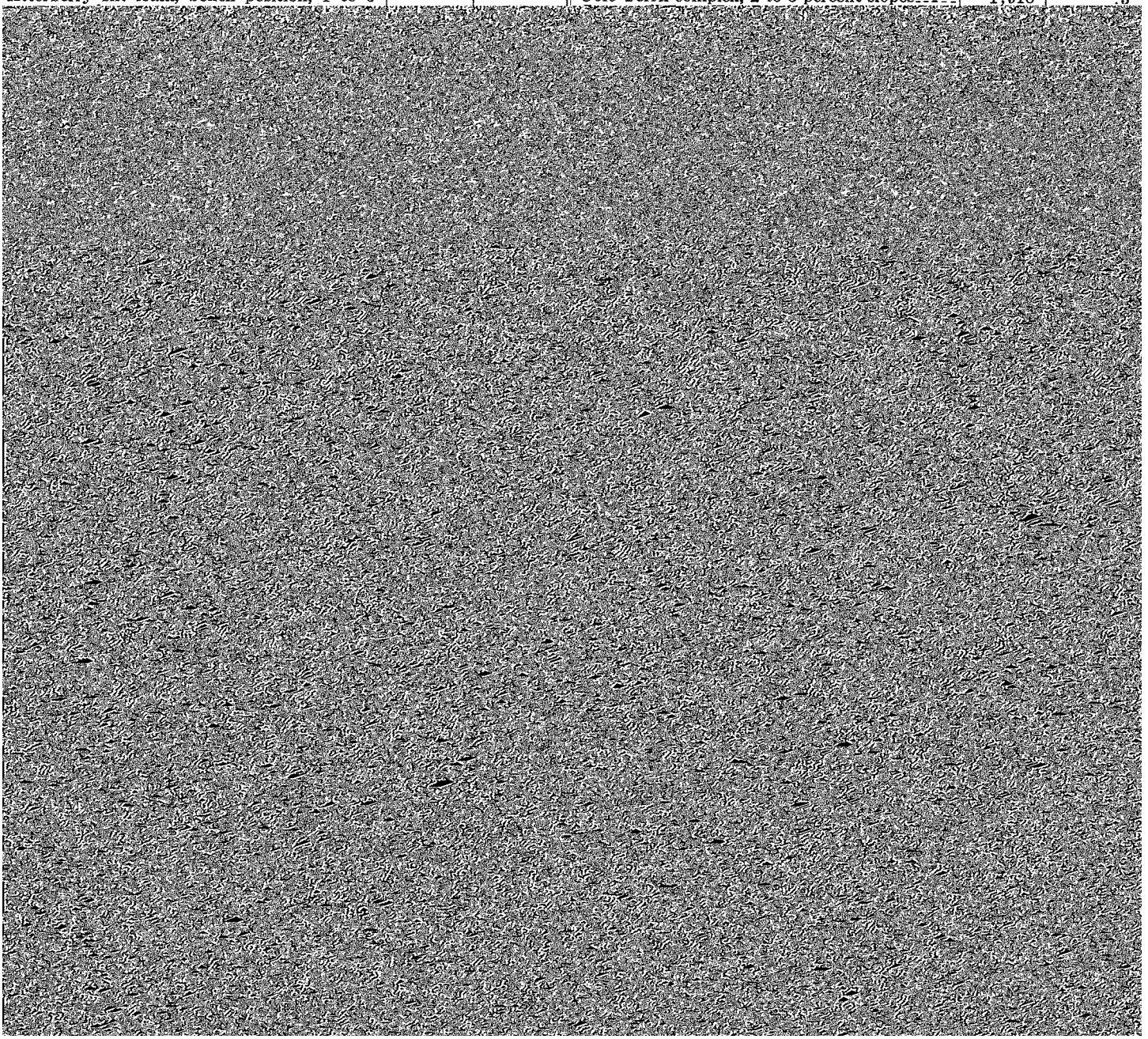


TABLE 2.—*Approximate acreage and proportonate extent of soils mapped*—Continued

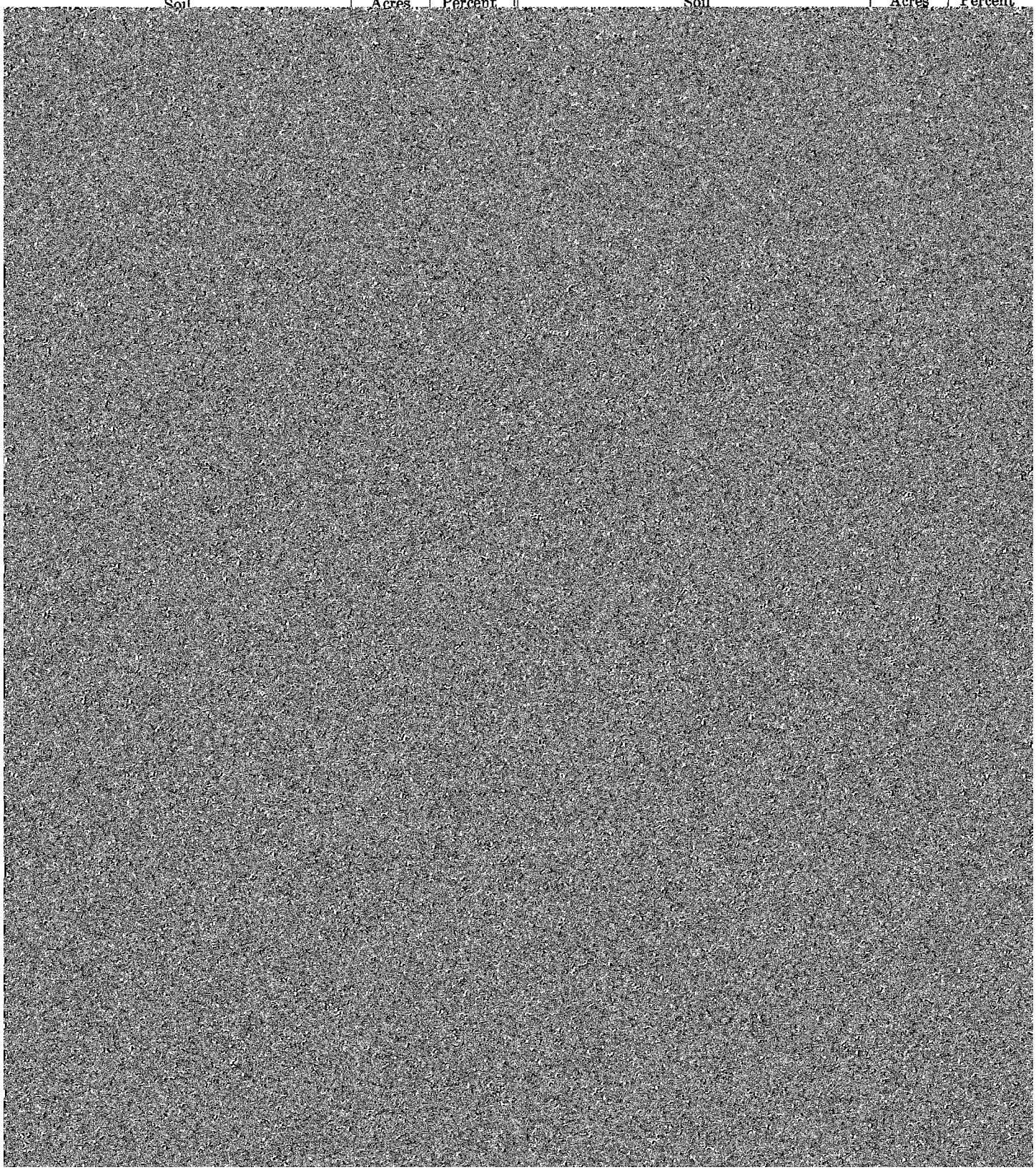
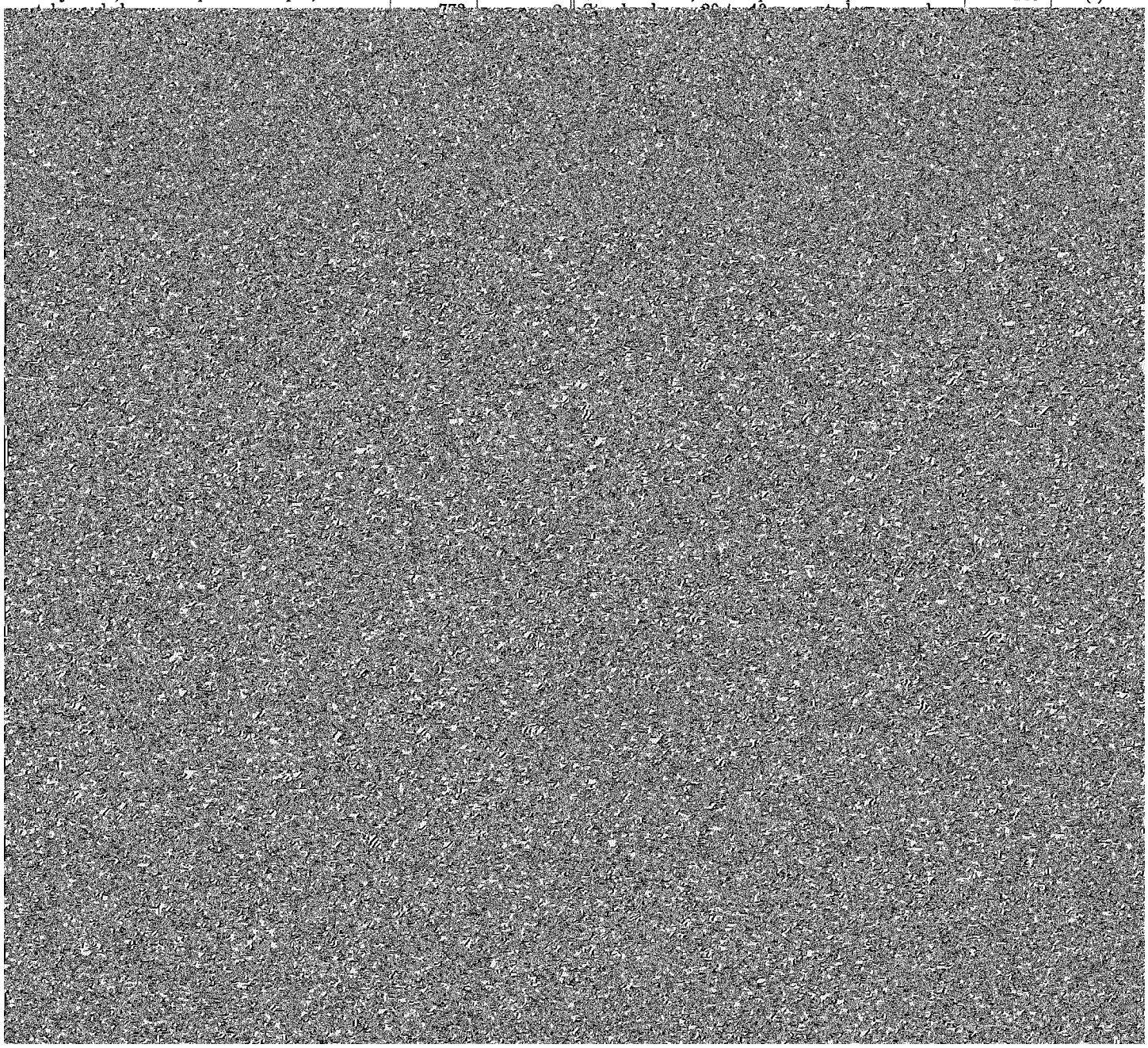


TABLE 2.—*Approximate acreage and proportonate extent of soils mapped*—Continued

Soil	Acres	Percent	Soil	Acres	Percent
Lindley loam, 14 to 20 percent slopes, moder-			Storden loam, 3 to 9 percent slopes	125	(1)



This soil is not very productive. Because it occurs in small areas, it is normally cropped the same as the adjacent soils. If used for row crops, this soil should be contoured or terraced to help control erosion. Laying interceptor tile lines in the more permeable, higher lying, adjacent soils will improve the drainage. (Capability subclass IIIw.)

Adair clay loam, 5 to 9 percent slopes, moderately eroded (AaC2).—At best, this soil is suitable for only limited cultivation. As a rule, it is cropped along with the adjacent soils. It may need drains and terraces. Yields are normally low. (Capability subclass IIIw.)

Adair clay loam, 9 to 14 percent slopes, moderately eroded (AaD2).—This soil includes areas in which the surface layer is more than 8 inches thick.

This soil is best suited to long-term pasture. If it is needed for meadows, oats followed by several years of hay is a good cropping sequence. (Capability subclass IVe.)

ADAIR SOILS, SEVERELY ERODED

Adair soils, 5 to 9 percent slopes, severely eroded (AbC3).—The profile of these soils is like the representative profile of Adair clay loam, except that the surface layer is less than 4 inches thick. The gritty silty clay subsoil is exposed in some spots.

These soils are difficult to till because some of the clayey subsoil is mixed with the original surface soil. Meadow or pasture is the best long-time use. To insure good yields, the fertility will probably have to be improved. (Capability subclass IVe.)

Adair soils, 9 to 14 percent slopes, severely eroded (AbD3).—The profile is like the representative profile of Adair clay loam, except that the surface layer is generally less than 4 inches thick. In some areas, the gritty silty clay subsoil is exposed.

This unit is best suited to hay or pasture. Probably the fertility will have to be improved before pastures can be established. (Capability subclass IVe.)

Alluvial land

This land type is composed of freshly laid river deposits that have not been in place long enough for distinct horizons to develop. The texture varies but is predominantly loam or silt loam. The areas are channeled and contain many low natural levees, or ridges, and numerous small ponds, sloughs, and little oxbow lakes. They are frequently flooded. The natural drainage varies from poor in the channels to good on the ridges. Because of the flood hazard, this land type is not suitable for cultivation unless it is protected by levees. In many protected areas, there are good stands of hardwood.

Alluvial land (Ac).—Much of this land type lies along the Des Moines River and the Raccoon River. A few areas are along the Skunk River and the larger creeks. If this land type is cultivated, a corn-soybean rotation is suitable. (Capability subclass IIw.)

Ames series

The Ames soils developed from Cary glacial till, under forest. They occur in the northern part of the county on upland flats near the Skunk and Des Moines Rivers and are near the Hayden soils. They are nearly level and are of minor extent. Figure 7 shows the position of the Ames soils on the landscape.

These soils are low in fertility and are not very productive. Generally, the surface soil and the upper part of the subsoil are medium acid. The water-holding capacity is good. Drainage is poor, and artificial drainage is needed to insure good yields. Tile drains do not work well, because the subsoil is very slowly permeable.

Some areas of Ames soils are used for crops; others are used for wooded pasture.

AMES LOAM

The following profile is representative of Ames loam.

0 to 4 inches, very dark gray, friable, slightly acid loam.
4 to 12 inches, grayish-brown to light brownish-gray, friable loam to sandy loam; light gray when dry; breaks into platy pieces.
12 to 36 inches, olive-brown to olive-gray, firm to very firm, heavy clay loam; middle part of layer is gritty, light silty clay; mottles of olive yellow and yellowish brown are common.
36 to 60 inches, light brownish-gray, firm loam; generally calcareous at 40 inches.

Ames loam (Ad).—The profile of this soil is like the representative profile. If the drainage can be improved, preferably by shallow surface ditches, a crop sequence of corn-soybeans-oats-meadow can be used. An alternative use is pasture. (Capability subclass IIIw.)

Ankeny series

The Ankeny series consists of droughty soils that developed from sandy material washed down from the slopes above. They are found mostly on foot slopes in the northeastern part of the county, east of the Skunk River. Generally, they lie downslope from the more rolling Hagener and Farrar soils. The slope range is 1 to 4 percent. The natural vegetation was mostly prairie grass.

These soils have a low water-holding capacity and are somewhat excessively drained. They are slightly acid to medium acid. They are low in fertility and only moderately productive. Wind erosion is a hazard.

ANKENY SANDY LOAM

The following profile is representative of Ankeny sandy loam.

0 to 10 inches, very dark grayish-brown, very friable sandy loam
10 to 30 inches, dark-brown to brown, very friable to loose sandy loam.
30 to 40 inches, yellowish-brown, loose sandy loam to sand.

In some areas the texture is loamy sand in all layers, and in other areas it is more loamy throughout. Some of the level areas have a foot or so of recently deposited coarse sand that has washed down from the slopes above.

Ankeny sandy loam, 0 to 2 percent slopes (AeA).—The profile of this soil is like the representative profile described. Coarse sand sediments have been deposited in some areas.

This soil is suitable for cultivation. It can be used for a corn-oats-meadow rotation if protected from wind erosion. It can also be used for alfalfa. Tillage methods that leave the crop residues on the surface will help to reduce wind erosion. (Capability subclass IIs.)

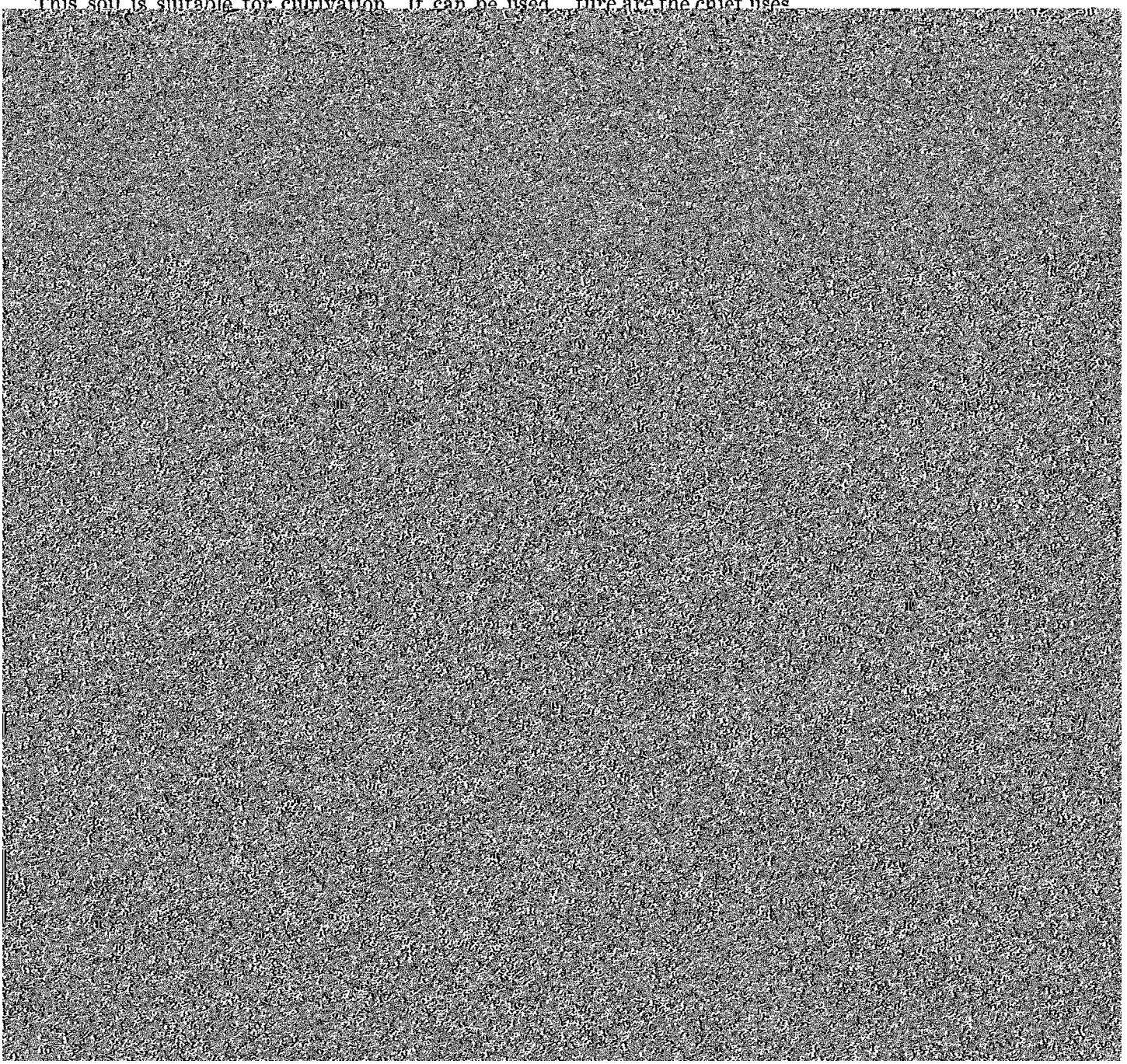
Ankeny sandy loam, 2 to 5 percent slopes (AeB).—Harmful deposits of sand are less common on this soil than on Ankeny sandy loam, 0 to 2 percent slopes.

This soil is suitable for cultivation. It can be used for a corn-oats-meadow rotation if protected from wind erosion. It can also be used for alfalfa. Tillage methods that leave the crop residues on the surface will help to reduce wind erosion. (Capability subclass IIs.)

Bauer series

The Bauer series consists of shallow soils that developed from shale and have shale fragments in the profile below a depth of 15 inches. They occur in hilly and steep areas along the Des Moines River. The slope range is 5 to 40 percent.

These soils are medium acid to strongly acid. They are very erodible. The drainage is moderately good, and the permeability is slow to moderate. The fertility and productivity are low. Woodland and wooded pasture are the chief uses.



permeable. The upper part of the profile is slightly acid to medium acid. The native vegetation was prairie grass.

These soils are moderately fertile and are moderately productive under good management. Some of the acreage is used for crops. Small areas that are associated with steep soils are used for pasture.

BLOCKTON SILT LOAM

The following profile is representative of Blockton silt loam. The two units mapped in Polk County have profiles that differ slightly from this, and these differences are noted in their descriptions.

0 to 12 inches, black, friable silt loam.
12 to 18 inches, black and gray, friable silt loam.
18 to 42 inches +, very dark gray to dark gray, very firm silty clay.

The surface layer varies in thickness and color. The 12- to 18-inch layer is platy in some areas.

Blockton silt loam, 0 to 2 percent slopes (BbA).—This soil has a thicker surface layer than that of the representative profile. In many areas, it seems to be a "two-

BUCKNER LOAMY SAND

The following profile is representative of Buckner loamy sand.

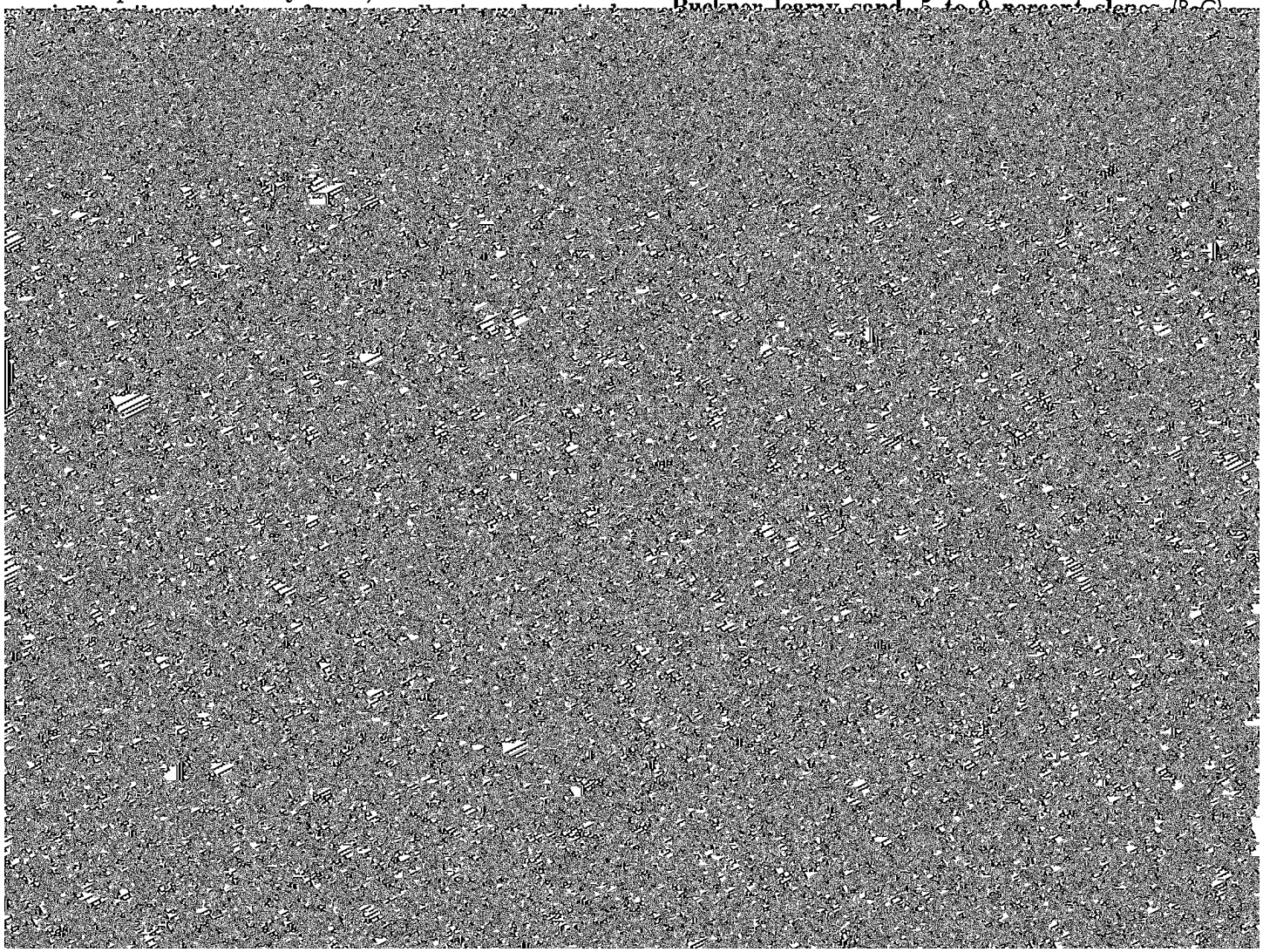
0 to 9 inches, dark grayish-brown, loose, loamy coarse sand.
9 to 30 inches, dark-brown, loose, loamy coarse sand.
30 to 50 inches +, very dark grayish-brown, loose, loamy coarse sand.

In some areas, the texture is sandy loam. In level or nearly level areas, the profile contains fine gravel.

Buckner loamy sand, 0 to 2 percent slopes (BcA).—Where water is available for irrigation, this soil has some potential for melons and other specialty and truck crops and for small grains and alfalfa. Tillage practices that leave crop residues on the surface will help protect the soil from wind erosion. (Capability subclass IIIs.)

Buckner loamy sand, 2 to 5 percent slopes (BcB).—This soil is subject to erosion by water as well as by wind. Use and management are the same as for Buckner loamy sand, 0 to 2 percent slopes. (Capability subclass IIIs.)

Buckner loamy sand, 5 to 9 percent slopes (BcC)



They are occasionally wet because of runoff and seepage from the slopes above. Because the subsoil varies in permeability from moderate to slow, tile drains may not work well in all areas. The upper part of the profile is medium acid. Because these soils generally occur in small areas, they are farmed like the adjacent soils.

CANTRIL SILT LOAM

The following profile is representative of Cantril silt loam.

0 to 10 inches, very dark grayish-brown, friable silt loam.
10 to 18 inches, grayish-brown, friable silt loam.
18 to 40 inches, dark grayish-brown, firm silty clay loam; mottles of strong brown and yellowish brown are common.
40 to 48 inches +, dark-gray, friable silt loam; many strong-brown mottles.

The surface layer varies in thickness. In some level areas the color of the subsoil approaches olive gray, which indicates somewhat poorer natural drainage in these spots. In some places the texture approaches loam or clay loam.

Cantril silt loam, 0 to 2 percent slopes (CaA).—The profile of this soil is like the representative profile. Some areas that are poorly drained and have a gray subsurface horizon are included with this soil. This soil receives some runoff from adjacent slopes.

If this soil is drained and protected from runoff, it is suitable for intensive cultivation. However, because it occurs in small areas, it is usually farmed in the same way as the adjacent soils. (Capability subclass IIw.)

Cantril silt loam, 2 to 5 percent slopes (CaB).—This soil has a profile like the representative profile described. It has a slight erosion hazard if farmed intensively. Ordinarily, it is not subject to flooding. Some areas need grassed waterways to prevent gullying. This soil is suitable for intensive cultivation, but, because it occurs in small areas, it is generally farmed in the same way as the adjacent soils. (Capability subclass IIe.)

Chaseburg series

The Chaseburg series consists of moderately well drained to imperfectly drained, light-colored soils that developed from local alluvial material. They occur in the southeastern part of the county, on gentle foot slopes below Fayette soils and on the level bottoms

CHASEBURG SILT LOAM

The following profile is representative of Chaseburg silt loam.

0 to 40 inches +, grayish-brown to dark grayish-brown, friable silt loam; light brownish gray in the lower part.

The upper part of the profile varies somewhat in color. The more nearly level areas are somewhat grayer and more mottled in the lower part.

Chaseburg silt loam, 0 to 2 percent slopes (CbA).—The profile of this soil is like the representative profile described. Some areas are inadequately drained and are likely to be flooded. Where water concentrates, grassed waterways are desirable. Diversion terraces may be needed to divert water that runs off the adjacent slopes.

This soil is potentially very productive. It is well suited to corn, soybeans, and pasture. Because it occurs in small areas, it is usually cropped in the same way as the adjacent soils. (Capability class I; some areas subject to flooding are in class V.)

Chaseburg silt loam, 2 to 5 percent slopes (CbB).—This soil has a profile like the representative profile described. It has a slight erosion problem as well as a wetness problem. Water often concentrates in the lower areas. Grassed waterways will help to control runoff and prevent gullying. Diversion terraces may be needed to divert water that runs off the higher adjacent slopes. Because this soil occurs in small areas, it is usually cropped in the same way as the adjacent soils. (Capability subclass IIe.)

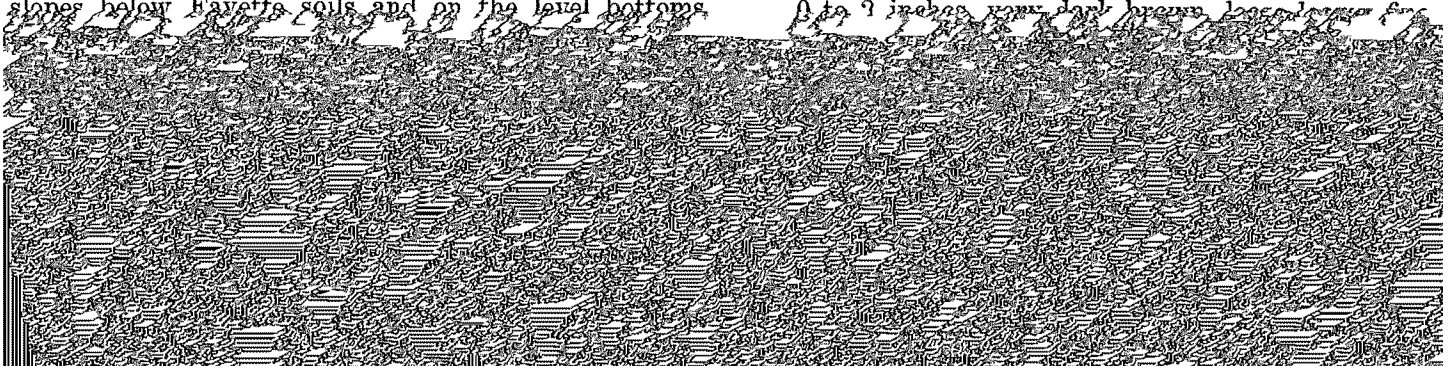
Chelsea series

The Chelsea series consists of sandy, excessively drained soils that are very droughty. They occur on a few slopes along the eastern and southern sides of the Des Moines and Raccoon Rivers, where the wind blew the fine sand from the river bottoms. They formed under forest and are low in organic matter.

These soils are low in fertility and productivity. They are slightly acid to medium acid in the upper part of the profile. Each of the soils is eroded to varying degrees. At present, they are used mostly for woodland and pasture. Wind and water erosion are serious hazards.

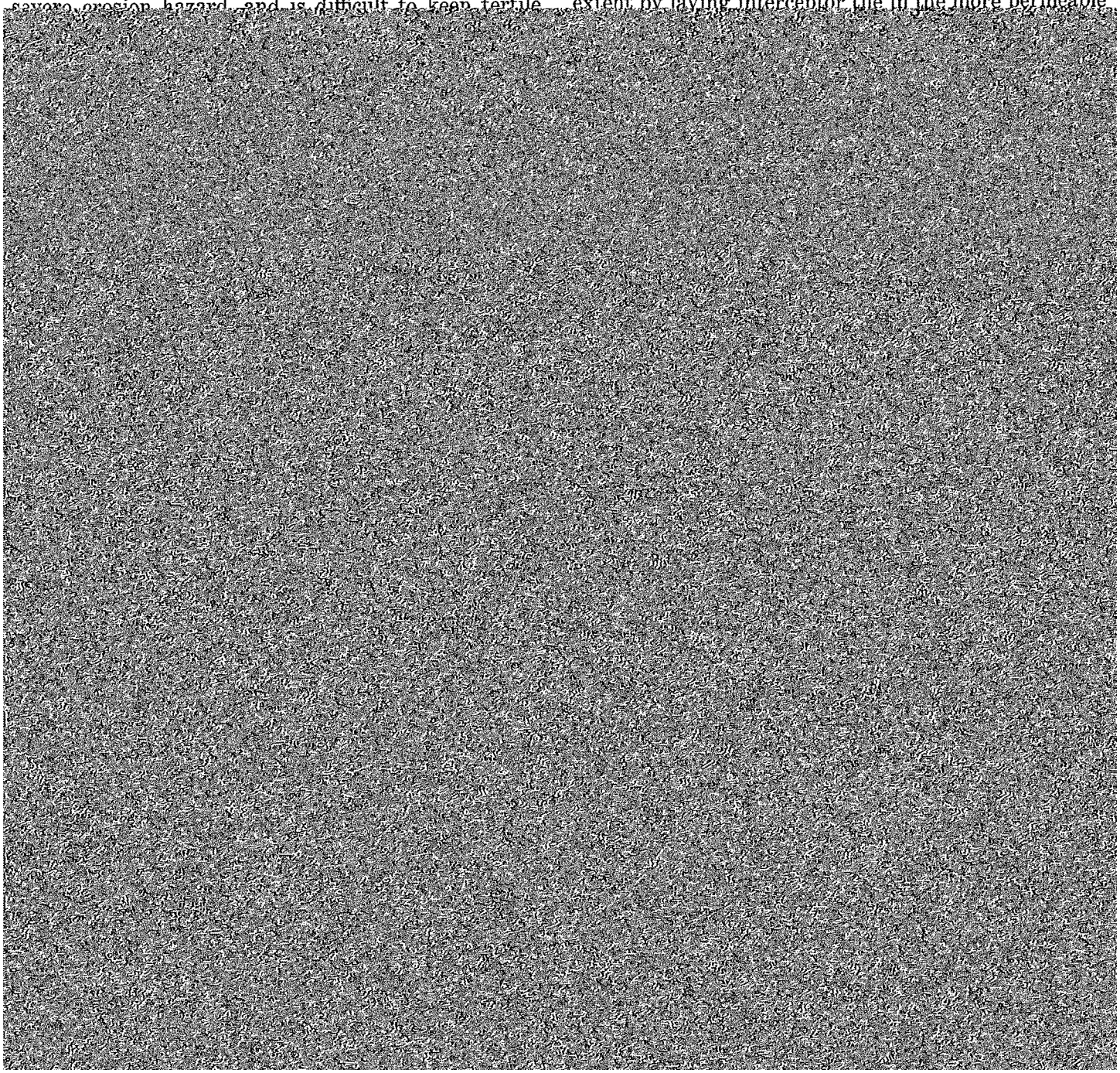
CHELSEA LOAMY FINE SAND

The following profile is representative of Chelsea loamy fine sand.



Chelsea loamy fine sand, 5 to 9 percent slopes, eroded (CcC2).—This soil is droughty and erodible. Fertility is hard to maintain. For these reasons, this soil is not well suited to row crops. It can be used for a small grain followed by several years of meadow, or it can be used for rye or other small grain every year. Crop residues left on the surface will help to control wind erosion. Long-term pasture and woodland are suitable uses for this soil if it is not needed for hay or small grains. (Capability subclass IVs.)

Chelsea loamy fine sand, 9 to 14 percent slopes, eroded (CcD2).—Because this soil is droughty, has a severe erosion hazard, and is difficult to keep fertile,



Included are some areas of Clarinda soils that have slopes of less than 5 percent. (Capability subclass IIIw.)

CLARINDA SOILS, SEVERELY ERODED

Clarinda soils, 5 to 9 percent slopes, severely eroded (CeC3).—The dark surface layer is less than 3 inches thick. The texture of the plow layer is silty clay.

These soils are best suited to hay or pasture. Renovating pastures may be difficult because the surface soil is clayey and sticky. Many areas are too small to manage separately. Seepage can be controlled to some extent by laying interceptor tile in the more permeable

profile described. It is slightly erodible when farmed intensively.

If the row crops are planted on the contour, a rotation of corn-soybeans-corn-oats-meadow is suitable for this soil. If the row crops are not planted on the contour, a rotation of corn-corn-oats-meadow-meadow is suitable. (Capability subclass IIe.)

Clarion loam, 2 to 5 percent slopes, moderately eroded (CfB2).—This soil has a profile like the representative profile described, except that the dark surface layer is thinner and the depth to calcareous material is normally less. Because this soil ordinarily occurs on low, sharply rounded knobs, it has a slightly greater erosion hazard than Clarion loam, 2 to 5 percent slopes.

A crop sequence of corn-corn-oats-meadow-meadow is suggested if the corn is not planted on the contour. A rotation of corn-soybeans-corn-oats-meadow is suggested if the row crops are planted on the contour. Soil tests should be made to determine lime and fertilizer needs. (Capability subclass IIe.)

Clarion loam, 5 to 9 percent slopes (CfC).—This soil has a slight to moderate erosion hazard. If the row crops are planted on the contour, a rotation of corn-corn-oats-meadow-meadow is suggested. If the soil is terraced, a rotation of corn-corn-oats-meadow is suitable. If the soil is neither contoured nor terraced, 3 years of meadow following 1 year of corn and 1 year of oats are necessary to keep erosion to a reasonable level and maintain longtime productivity. (Capability subclass IIIe.)

Clarion loam, 5 to 9 percent slopes, moderately eroded (CfC2).—The profile of this soil is generally a few inches shallower to calcareous material than the representative profile of Clarion loam. The dark surface soil is thinner than that in the representative profile.

A rotation of corn-corn-oats-meadow is suitable if this soil is terraced. If it is contoured but not terraced, a rotation of corn-corn-oats-meadow-meadow is suggested. If it is neither terraced nor contoured, a rotation of corn-oats-meadow-meadow-meadow will be necessary to keep soil losses low and to maintain long-term productivity. (Capability subclass IIIe.)

Clarion loam, 9 to 14 percent slopes, moderately eroded (CfD2).—The profile of this soil is shallower to calcareous material than the representative profile of Clarion loam. Generally, the dark surface soil is thinner (4 to 7 inches thick) than that in the representative profile, but in some areas the surface layer is as thick as or thicker than that in the profile described. The hazard of erosion is greater than on less strongly sloping Clarion loams.

If this soil is terraced, a rotation of corn-corn-oats-meadow-meadow is suitable. Alternative uses are permanent hay and pasture. (Capability subclass IIIe.)

Clarion loam, 14 to 20 percent slopes, moderately eroded (CfE2).—The profile of this soil is like the representative profile described, except that the dark surface layer is generally thinner (less than 8 inches thick) and the depth to calcareous material is less. Included are some areas in which the surface soil is 10 to 12 inches thick. These areas are mostly pastures that have not been grazed heavily and have never been cultivated. Also included are many small spots of Storden soils, which are calcareous at, or within 12 inches of, the surface.

Permanent hay or pasture is a suitable use for this soil. (Capability subclass IVe.)

Clarion loam, 20 to 30 percent slopes, moderately eroded (CfF2).—This soil is found along drainageways and small creeks, in places where the native vegetation was not forest. The surface layer is generally less than 4 inches thick, and in many areas all of it has been removed by erosion. Small gullies have formed in some areas. Included are many areas, less than half an acre in size, of Storden soils, which are calcareous at, or within 12 inches of, the surface.

Permanent pasture is the most suitable use for this soil. (Capability subclass VIIe.)

CLARION SOILS, SEVERELY ERODED

Clarion soils, 5 to 9 percent slopes, severely eroded (CkC3).—The dark surface layer is less than 4 inches thick. In many places, all of the original surface soil has been lost through erosion and the brown or yellowish-brown subsoil is exposed. The depth to calcareous material ordinarily ranges from 18 to 30 inches.

The sharp ridges and knobs on which this unit developed are particularly subject to geologic erosion, but some of the erosion has been caused by growing cultivated crops continuously in rows running straight up and down the slope.

If this unit is terraced, a rotation of corn-corn-oats-meadow-meadow is suitable. If it is contoured but not terraced, a rotation of corn-oats-meadow-meadow is suggested. If it is neither contoured nor terraced, 4 years of meadow should follow 1 year of corn and 1 year of oats. (Capability subclass IIIe.)

Clarion soils, 9 to 14 percent slopes, severely eroded (CkD3).—The surface layer of this unit is generally less than 4 inches thick. In many places, all of the original dark surface layer has been removed by erosion and the yellowish-brown subsoil is exposed. The depth to calcareous material is ordinarily 18 to 30 inches.

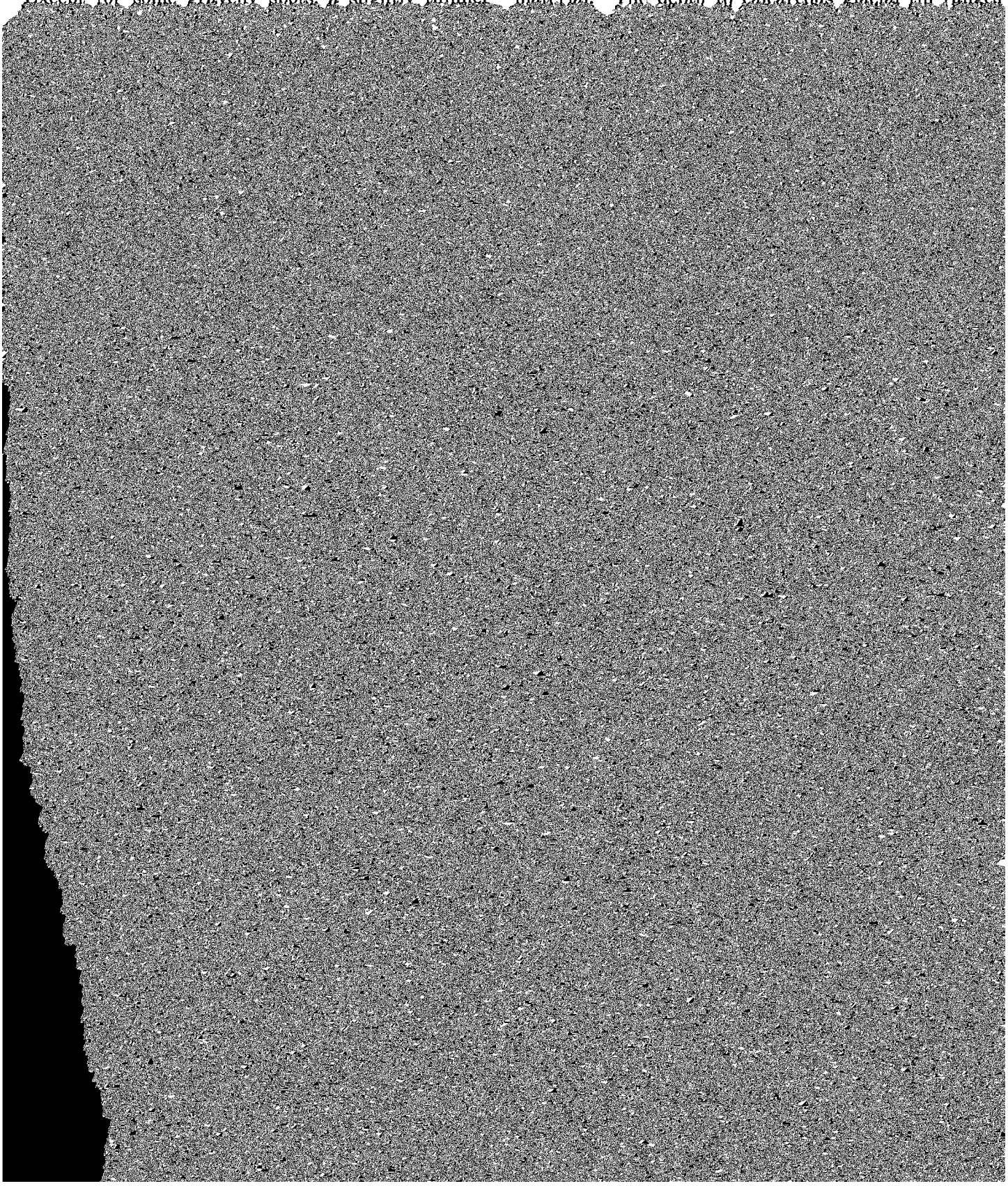
The thinness of the dark surface layer is partly due to geologic erosion of the ridges and knobs on which this unit occurs, and partly due to the practice of growing row crops too often in rows running up and down hill.

If this unit is terraced, a rotation of corn-oats-meadow is suitable. Otherwise, permanent hay or pasture is the most suitable use. (Capability subclass IVe.)

Clarion soils, 14 to 20 percent slopes, severely eroded (CkE3).—The dark surface layer of this unit is generally less than 4 inches thick. In many places, all of the original dark surface layer has been removed by erosion and the yellowish-brown subsoil is exposed. The depth to calcareous material is ordinarily 18 to 30 inches. Included are numerous areas, mostly less than half an acre in size, of Storden soils, which are calcareous at or near the surface. Long-term pasture is a suitable use for this unit. (Capability subclass VIe.)

CLARION LOAM, THIN SOLUM

Except for some gravelly spots, a slightly thinner



activity of rodents, some gravel is mixed with the silty material. The depth to calcareous glacial till ranges

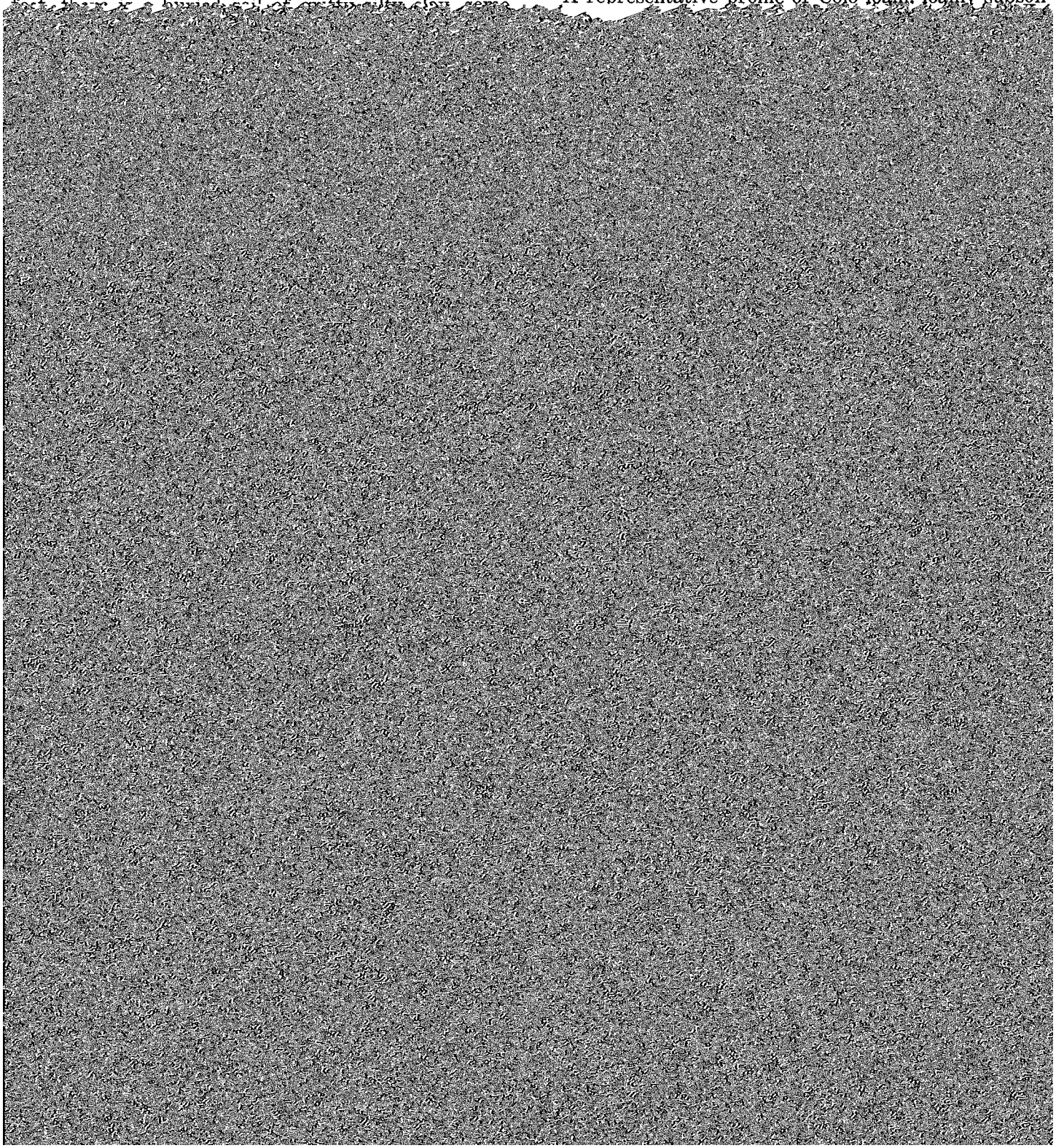
38 to 48 inches, mottled grayish-brown, pale-brown, and light brownish-gray, slightly firm silty clay loam.

The thickness of the dark surface layer ranges from 6 to 18 inches. In most areas, at depths of 3½ to 5 feet, there is a buried soil of gritty silty clay loam

nels and by the present meandering stream that it is unsuitable for cultivation. Its best use is woodland or pasture. (Capability class V.)

COLO LOAM, LOAMY SUBSOIL VARIANT

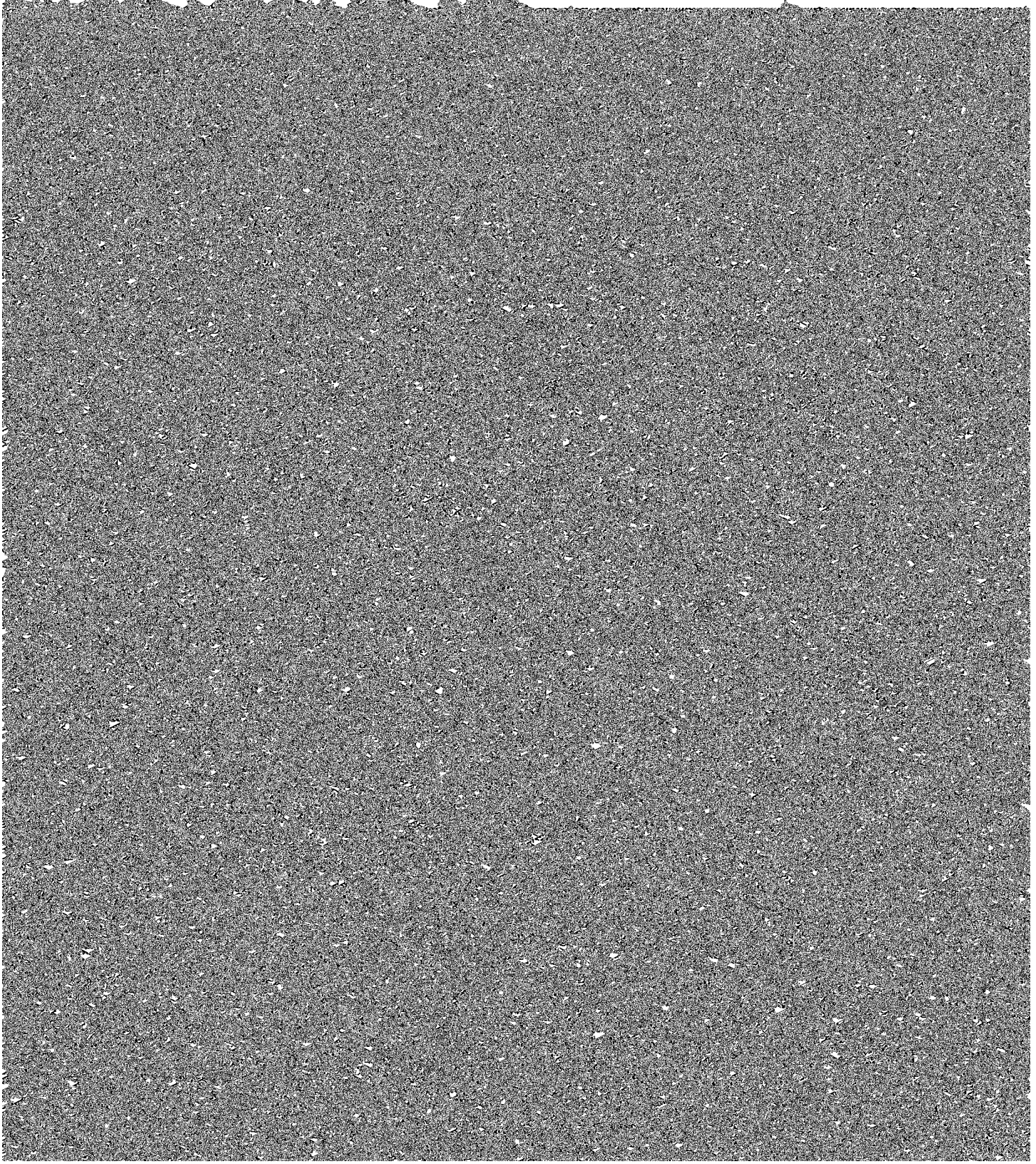
A representative profile of Colo loam, loamy subsoil



ageways in the northern two-thirds of the county. They are so closely associated that they were not mapped separately. The complex is about 50 percent Colo soils, about 30 to 40 percent Terril soils, and

nure should be seeded with the oats. (Capability subclass IIw.)

Crocker series



the roots will reach through the sand and into the underlying loamy material, which has a high moisture-holding capacity. (Capability subclass IVs.)

Crocker loamy fine sand, 14 to 20 percent slopes, moderately eroded (CuE2).—The profile of this soil is like the representative profile, except that the thickness of the sandy layers is nearer 12 inches than 24. Included are spots in which the mantle of fine sand is less than 12 inches thick. Woodland and pasture are the most suitable uses for this soil. (Capability subclass VIs.)

Crocker loamy fine sand, 20 to 30 percent slopes (CuF).—The profile of this soil is like the representative profile, except that the sandy layers are commonly about 12 inches thick. Areas that have a sandy layer only 6 inches thick are included.

This soil is not suitable for cultivation. It should be used for pasture or as woodland. (Capability subclass VIIs.)

Dickinson series

The soils of the Dickinson series are well drained to somewhat excessively drained. They developed in sandy material. The slope range is 0 to 30 percent. The texture of the surface soil ranges from loam to sandy loam. The depth to calcareous material ranges from 24 to more than 60 inches. The native vegeta-

A suggested rotation for this soil is corn-oats-meadow. Alternative crops are alfalfa, winter rye, or wheat. Because of the hazard of wind erosion, crop residues should be left on the surface whenever possible. (Capability subclass IIIs.)

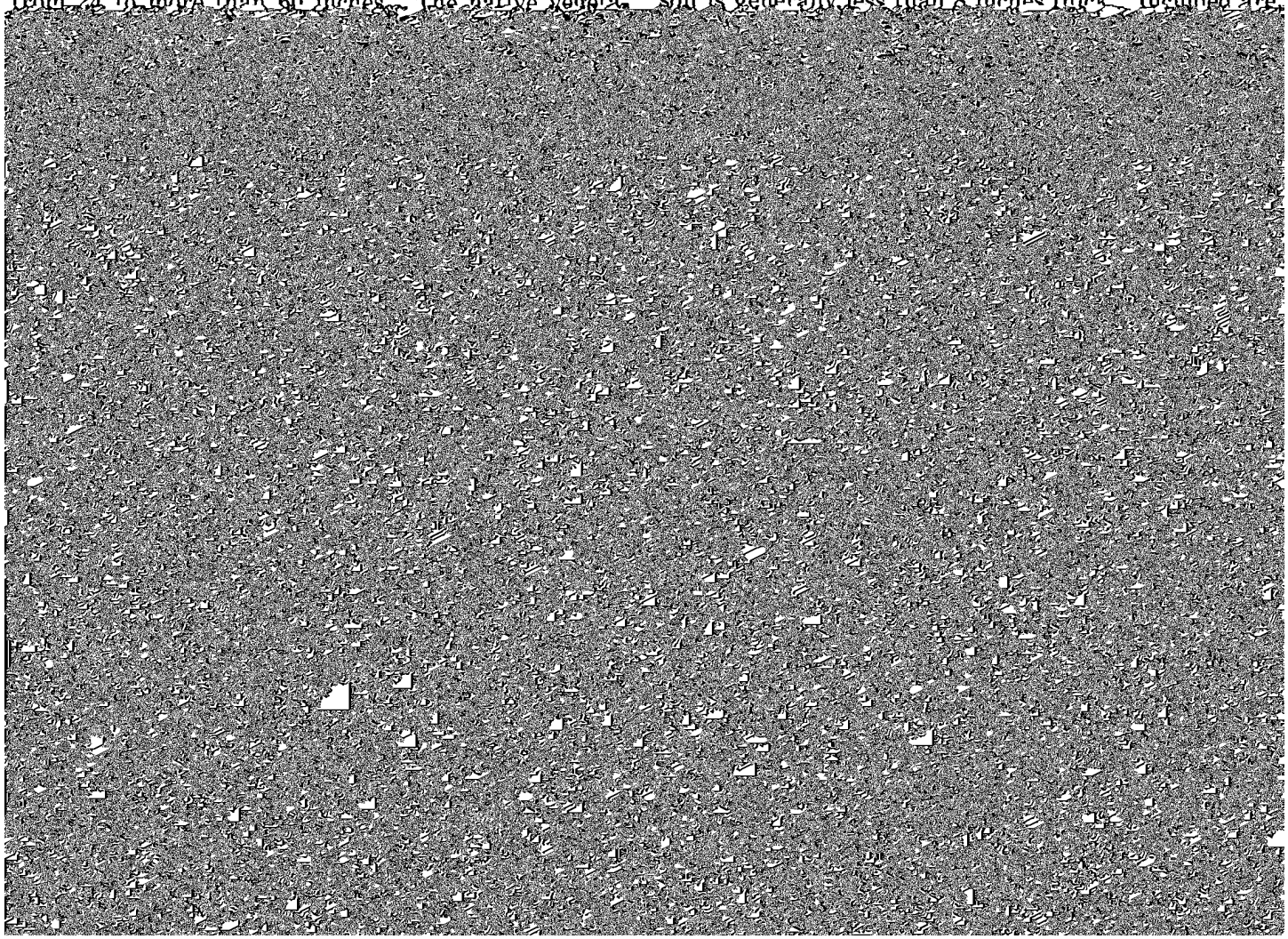
Dickinson fine sandy loam, 2 to 5 percent slopes (DaB).—This soil occurs on low knobs throughout the northern four-fifths of the county. Its profile is like the representative profile of Dickinson fine sandy loam.

A suggested rotation for this soil is corn-oats-meadow. Alternative crops are alfalfa, winter rye, and wheat. Crop residues should be left on the surface whenever possible to help prevent wind and water erosion. (Capability subclass IIIs.)

Dickinson fine sandy loam, 2 to 5 percent slopes, moderately eroded (DaB2).—The dark surface layer of this soil is generally less than 8 inches thick.

Probably this soil cannot be kept productive if row crops are grown more than 1 year in 3 or 4 years. A suggested rotation is corn-oats-meadow. Alternative crops are alfalfa, winter rye, or wheat. Crop residues left on the surface will help prevent wind and water erosion. (Capability subclass IIIs.)

Dickinson fine sandy loam, 5 to 9 percent slopes, moderately eroded (DaC2).—The dark surface layer of this soil is generally less than 8 inches thick. Included are



thin. In a few areas, the subsoil is exposed. The depth to the layer of loamy sand is less than in the representative profile of Dickinson fine sandy loam. The surface layer is lighter colored than that in the representative profile because it contains less organic matter.

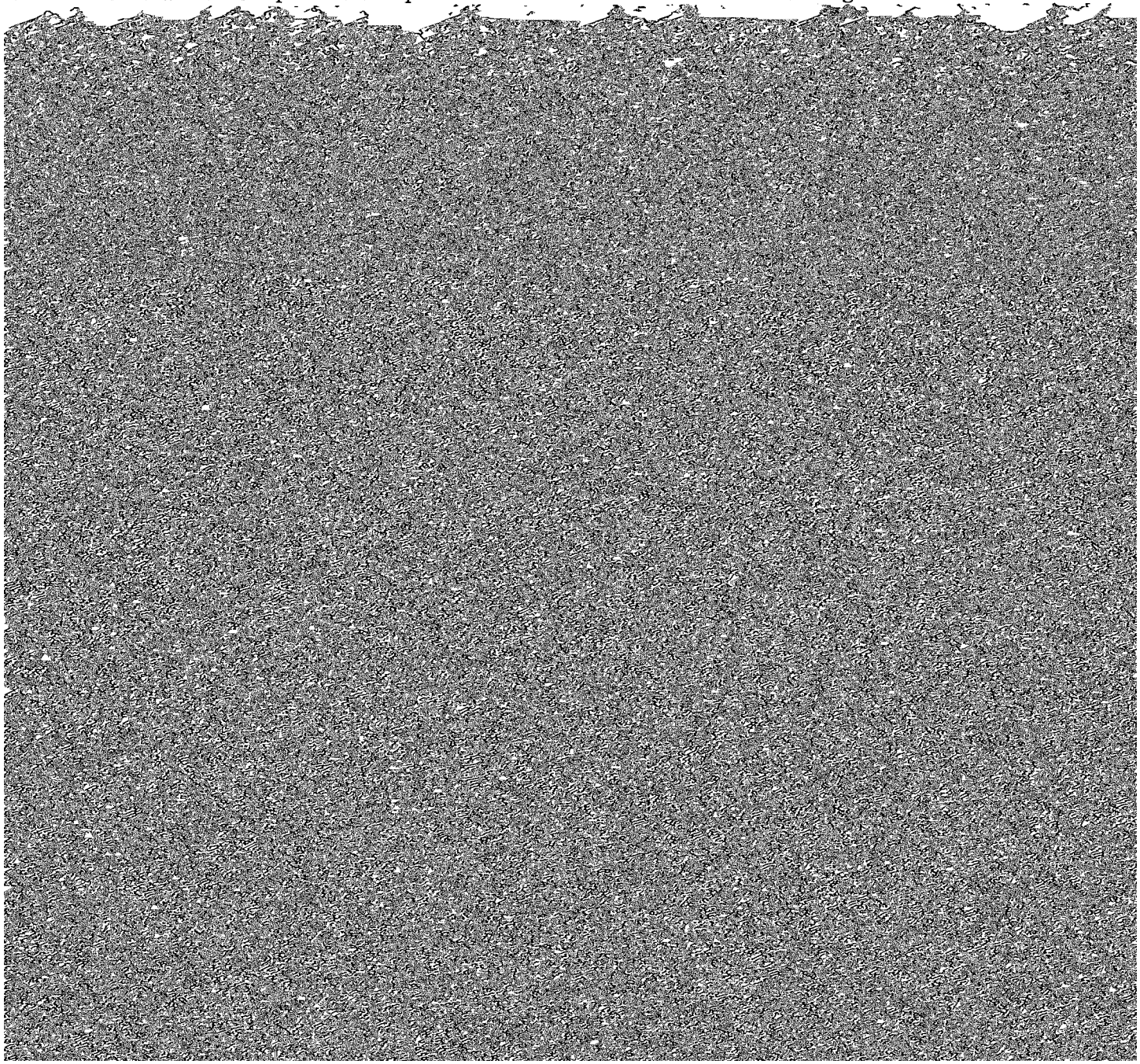
Long-term pasture is a suggested use for this unit. Probably lime and phosphate will be needed to improve the pasture. Because of droughtiness, the response to amendments is uncertain. (Capability subclass VIs.)

Dickinson soils, 14 to 20 percent slopes, severely eroded (DdE3).—The dark surface layer of this unit is normally less than 4 inches thick. It is much lighter colored than that in the representative profile of Dickinson loam, except that the surface layer is only 4 to 7 inches thick. This soil is best suited to permanent pasture. (Capability subclass VIs.)

Dickinson loam, 20 to 30 percent slopes, moderately eroded (DbF2).—The profile of this soil is like the representative profile of Dickinson loam, except that the surface layer is only 4 to 7 inches thick. This soil is best suited to permanent pasture. (Capability subclass VIIs.)

DICKINSON SANDY LOAM, BENCH POSITION

Dickinson sandy loams, bench position, occur on glacial outwash terraces along the Skunk and Des Moines



Dorchester series part of the county. They are associated with Faxotto

rotation of corn-corn-oats-meadow-meadow is suggested. An alternative use is pasture. (Capability subclass IIIe.)

Downs silt loam, 14 to 20 percent slopes, moderately eroded (DhE2).—The surface layers of this soil are somewhat thinner than those in the representative profile, and the total depth of the profile is less than that of the representative profile.

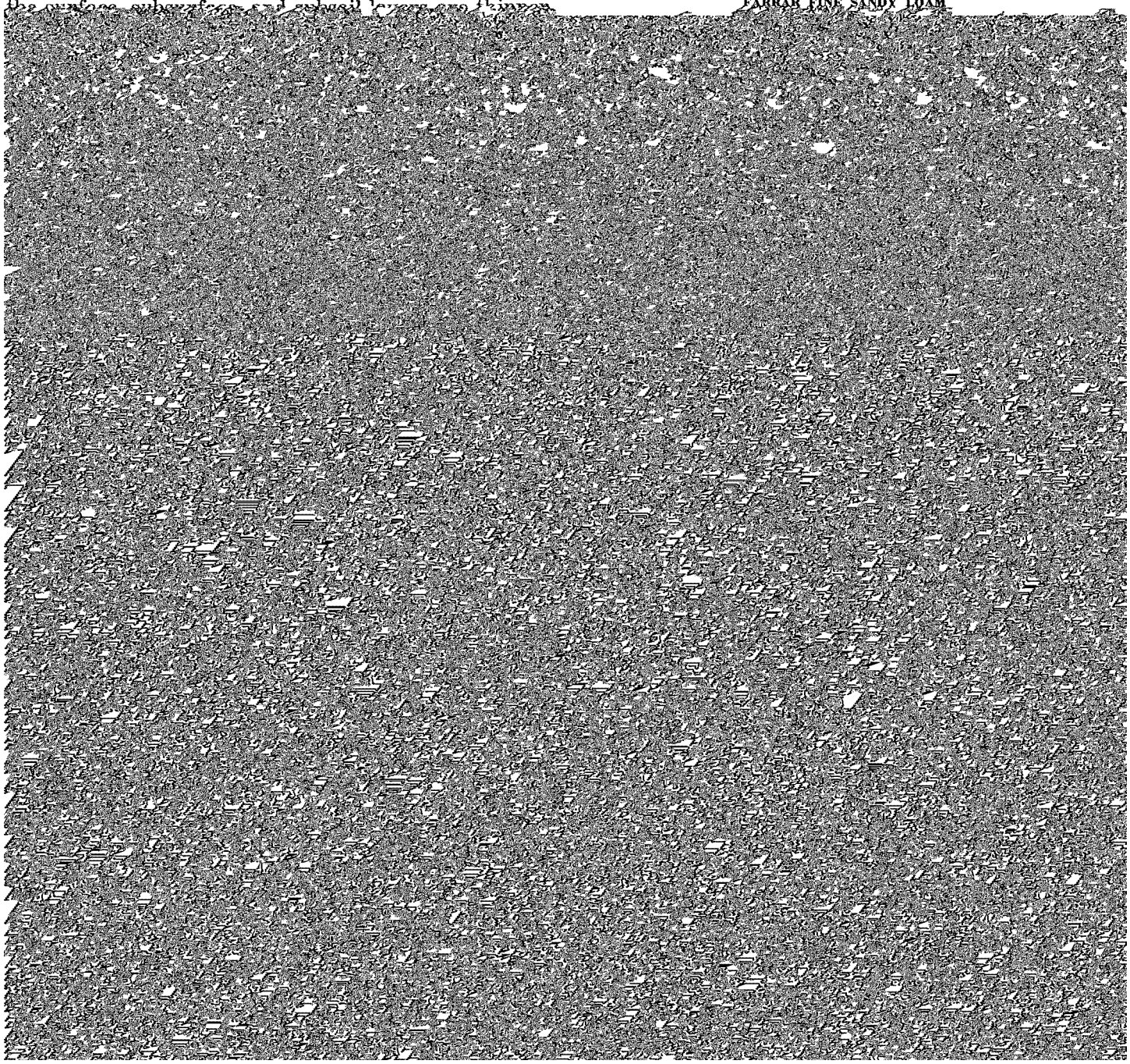
This soil is best suited to long-term hay, pasture, or woodland. (Capability subclass IVe.)

Downs silt loam, 20 to 30 percent slopes, moderately eroded (DhF2).—The profile of this soil is several inches shallower than the representative profile. Generally, the surface, subsurface, and subsoil layers are thinner

The fine sandy material in the upper layers of these soils was blown by wind from the adjacent river bottoms. The loam in the lower layers was deposited by the Cary glacier. The glacial material is friable. It is commonly calcareous below depths of 3 to 4 feet.

These soils are subject to wind and water erosion. They are slightly acid. The fertility is low. The gently sloping phases are used for corn, oats, and meadow, and they are moderately productive under good management. Tillage practices that leave crop residues on the surface help to prevent wind erosion. The steeper phases are used for pasture.

FARRAR FINE SANDY LOAM



surface to help control wind erosion. (Capability subclass IVs.)

Farrar fine sandy loam, 14 to 20 percent slopes, moderately eroded (FaE2).—This soil generally has a somewhat thinner dark surface layer than that of the representative profile. There are, however, some included areas where the surface layer is thicker because it is not eroded significantly. The total thickness of the sandy loam layers is about 6 to 15 inches. The depth to calcareous material ranges from about 18 to 27 inches.

Long-term pasture is the most suitable use for this soil. (Capability subclass VIs.)

Farrar fine sandy loam, 20 to 30 percent slopes, moderately eroded (FaF2).—The surface and subsurface layers of this soil are generally less than 15 inches thick. In most places the dark surface layer is 4 to 8 inches thick, but included are a few areas where the surface layer is thicker. This soil is generally leached to depths of 18 to 27 inches.

Long-term pasture or permanent pasture is the most suitable use for this soil. (Capability subclass VIIs.)

Fayette series

The Fayette series consists of well-drained, light-colored soils that developed from loess. The thickness of the loess ranges from 3 feet on the lower side slopes to more than 20 feet on the broad, level upland divides. The Fayette soils occur in the southeastern part of the county, mostly in the uplands, but to some extent on benches, or second bottoms. They are associated with Downs, Stronghurst, and Tama soils (fig. 8). The slope range is 0 to 40 percent. The native vegetation was trees.

Generally, the nearly level phases have a grayer and thicker subsurface layer than other phases. They have a slightly mottled subsoil, which is somewhat like that of the Stronghurst soils. The steeper phases have somewhat less clay in the subsoil than the gently sloping phases. In the severely eroded phases, the plow layer consists of yellowish-brown material from the subsoil.

The Fayette soils are moderately fertile. They are medium acid in the upper part of the profile and need lime. Under good management, the gently sloping phases are highly productive of corn, oats, and meadow—the chief crops grown. About a third of the gently sloping areas are forested. The steeper slopes are used for unimproved pasture and woodland. Erosion is slight to severe, depending on the slopes.

FAYETTE SILT LOAM

A representative profile of Fayette silt loam follows.

0 to 4 inches, dark grayish-brown, friable silt loam.
4 to 10 inches, grayish-brown, friable silt loam.
10 to 35 inches, yellowish-brown, slightly firm silty clay loam.
35 to 60 inches +, mottled yellowish-brown and reddish-brown, friable silt loam.

Fayette silt loam, 0 to 2 percent slopes (FbA).—This soil developed on the broad, forested ridgetops. It has thicker surface and subsurface layers than those described in the representative profile. It is slightly mottled in the subsoil. It has better natural drainage than the Stronghurst soils, however. A rotation of corn-corn-oats-meadow or corn-oats-meadow is suitable. (Capability class I.)

Fayette silt loam, 2 to 5 percent slopes (FbB).—The profile of this soil is like the representative profile, except that in some areas some of the dark surface soil and grayer subsurface layer has been removed by accelerated erosion. Included are some forested areas in which there has been little or no accelerated erosion.

If this soil is contoured, a rotation of corn-corn-oats-meadow is suitable. If it is not contoured, a rotation of corn-corn-oats-meadow-meadow is suggested. (Capability subclass IIe.)

Fayette silt loam, 2 to 5 percent slopes, moderately eroded (FbB2).—Most of the original dark surface layer and some of the subsurface layer of this soil have been removed by accelerated erosion. The depth to the yellowish-brown subsoil ranges from 4 to 8 inches.

A rotation of corn-corn-oats-meadow is suitable if this soil is contoured. A rotation of corn-corn-oats-meadow-meadow is suggested if the soil is not contoured. (Capability subclass IIe.)

Fayette silt loam, 5 to 9 percent slopes, moderately eroded (FbC2).—The depth to the yellowish-brown subsoil is generally only 4 to 8 inches. If this soil is terraced, a rotation of corn-corn-oats-meadow is suitable. If it is contoured, a rotation of corn-oats-meadow-meadow is suggested. (Capability subclass IIIe.)

Fayette silt loam, 9 to 14 percent slopes, moderately eroded (FbD2).—In this soil, the depth to the yellowish-brown subsoil generally is only 4 to 8 inches. Included are some forested areas where the surface layer is slightly darker colored and thicker than that in the representative profile.

If this soil is terraced to control erosion, a rotation of corn-corn-oats-meadow-meadow is suggested. Alternative uses are hay and pasture. (Capability subclass IIIe.)

Fayette silt loam, 14 to 20 percent slopes, moderately eroded (FbE2).—In this soil, the depth to the yellowish-brown subsoil is generally 4 to 8 inches. Included are some forested areas where the surface and subsurface layers are thicker than those in the representative profile.

Long-term pasture and woodland are suitable uses for this soil. (Capability subclass IVe.)

Fayette silt loam, 20 to 30 percent slopes, moderately eroded (FbF2).—Although the surface and subsurface layers generally are not so thick as those in the representative profile, roughly 30 to 40 percent of this soil is relatively uneroded.

Woodland is the most suitable use for this soil. (Capability subclass VIIe.)

Fayette silt loam, 30 to 40 percent slopes, moderately eroded (FbG2).—In most places, the surface layer of this soil is slightly thinner than that in the profile described.

This soil is best suited to woodland or pasture. (Capability subclass VIIe.)

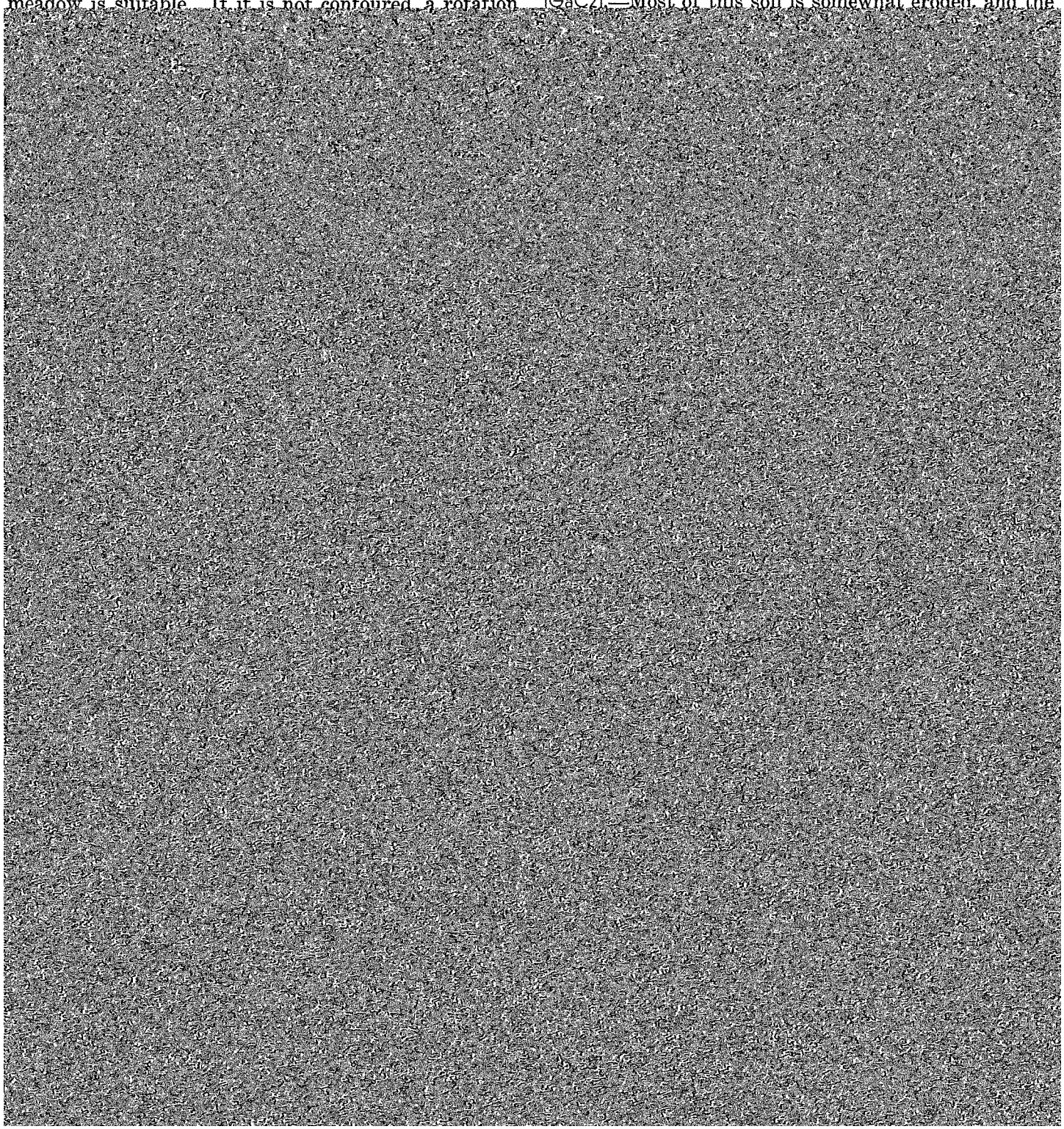
Fayette silt loam, bench position, 2 to 5 percent slopes (FcB).—This soil is found below the uplands, along

streams. It developed from loess over terrace deposits, while the Fayette soils in the uplands developed from loess over Kansan till. It receives some runoff water from the slopes above; hence, it may be more productive in dry years than the Fayette soils of similar slope in the uplands.

If this soil is contoured, a rotation of corn-corn-oats-meadow is suitable. If it is not contoured, a rotation

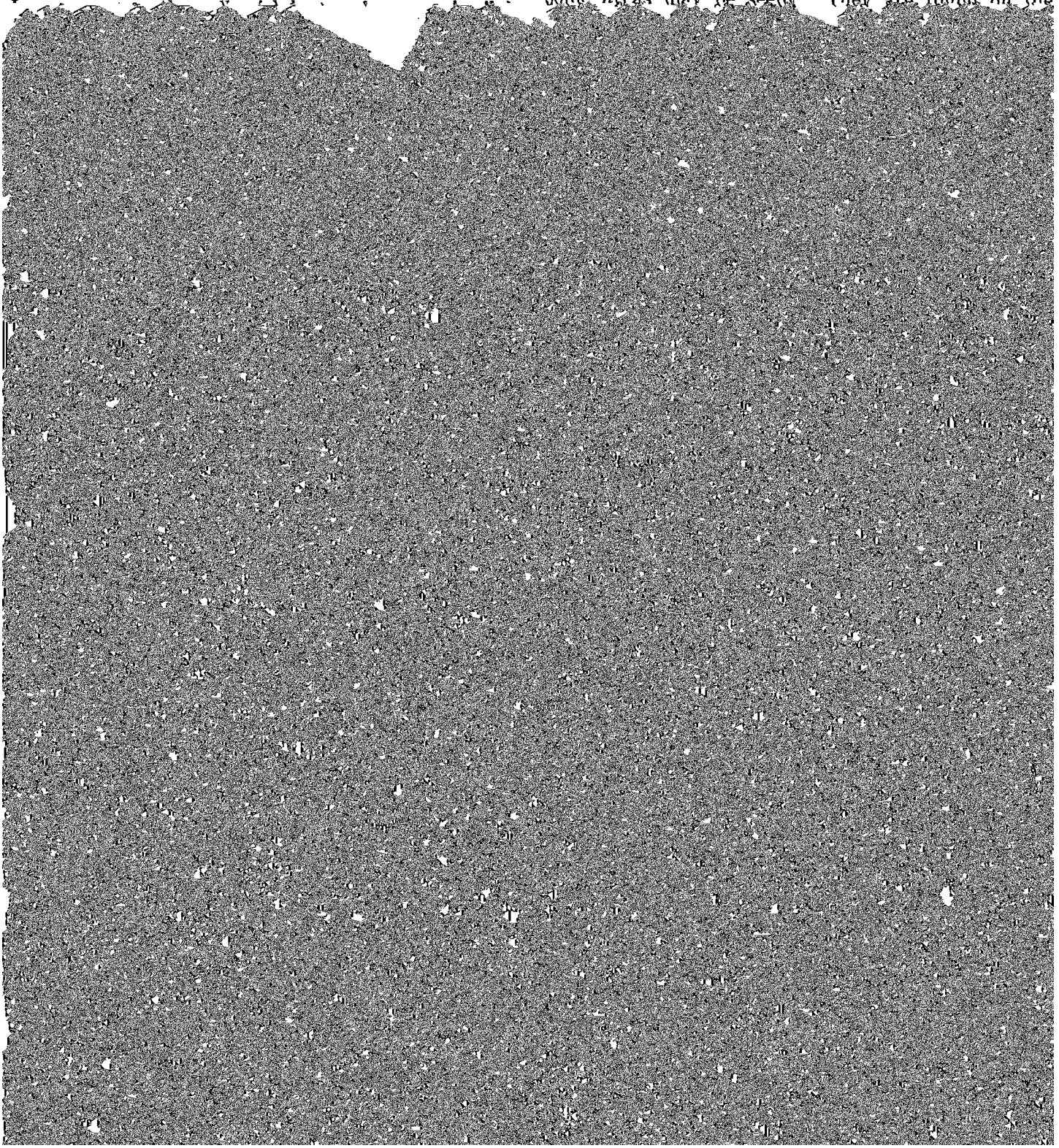
The thickness and color of the surface layer vary. In some areas, especially in Bloomfield Township, the material below depths of 3 or 4 feet is loam. Stones, pebbles, and some sand pockets are present in some small areas. There are also some spots of clay gumbotil.

Gara loam, 5 to 9 percent slopes, moderately eroded (GaC2).—Most of this soil is somewhat eroded, and the



long-term pasture or woodland. (Capability subclass VIe.)

Gara soils, 20 to 40 percent slopes, slightly to severely eroded (GbF2).—In most areas of this unit, the surface and subsurface layers are a few inches thinner than those in the representative profile of Gara loam.



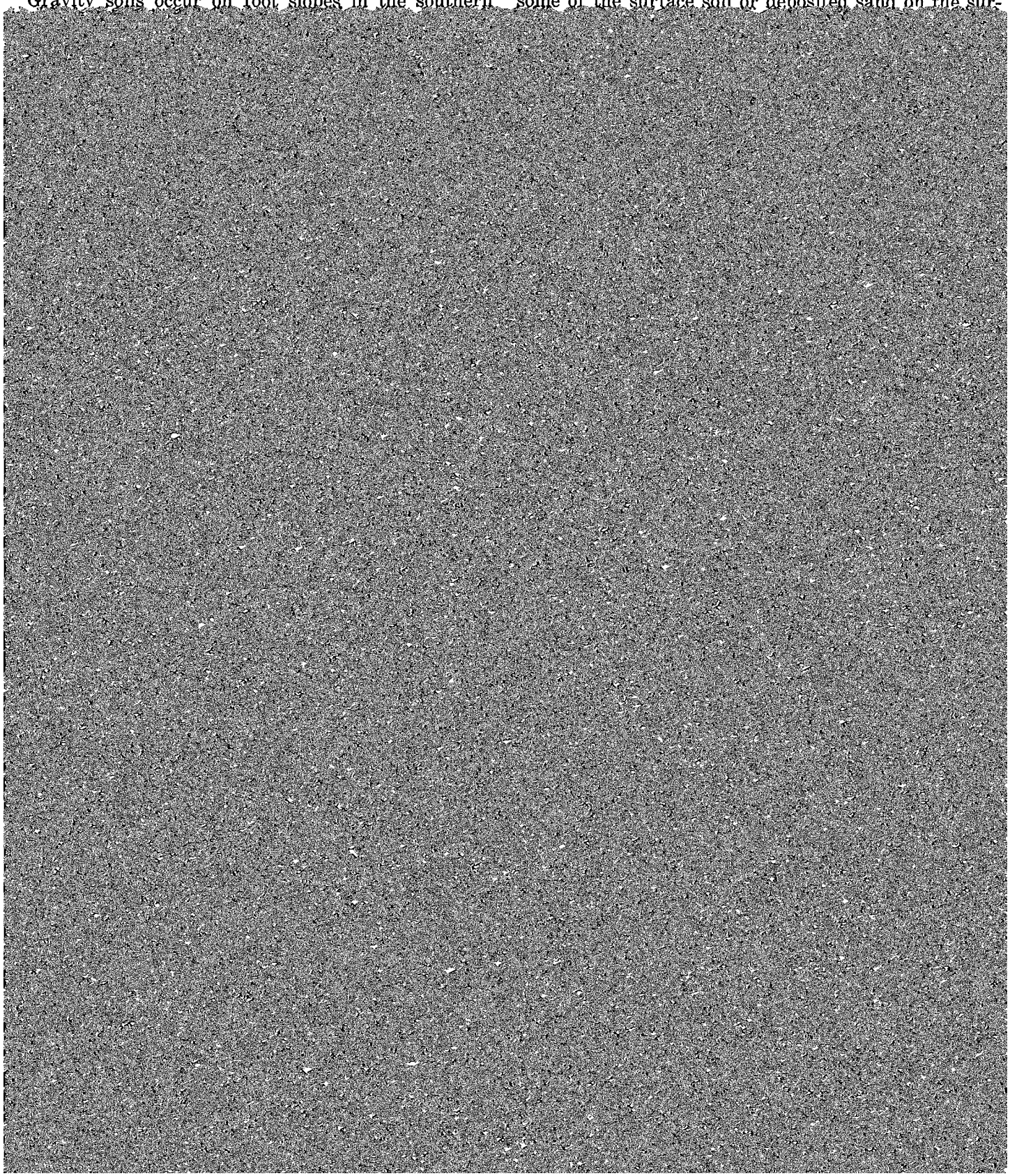
Gosport series

The Gosport series consists of light-colored soils that, like the Bauer and Runnells soils, formed from preglacial shale of Pennsylvanian age. These soils are naturally well drained, although in very wet seasons some areas may be seepy. They are found on the

The slope range is 2 to 4 percent. The native vegetation was prairie grass.

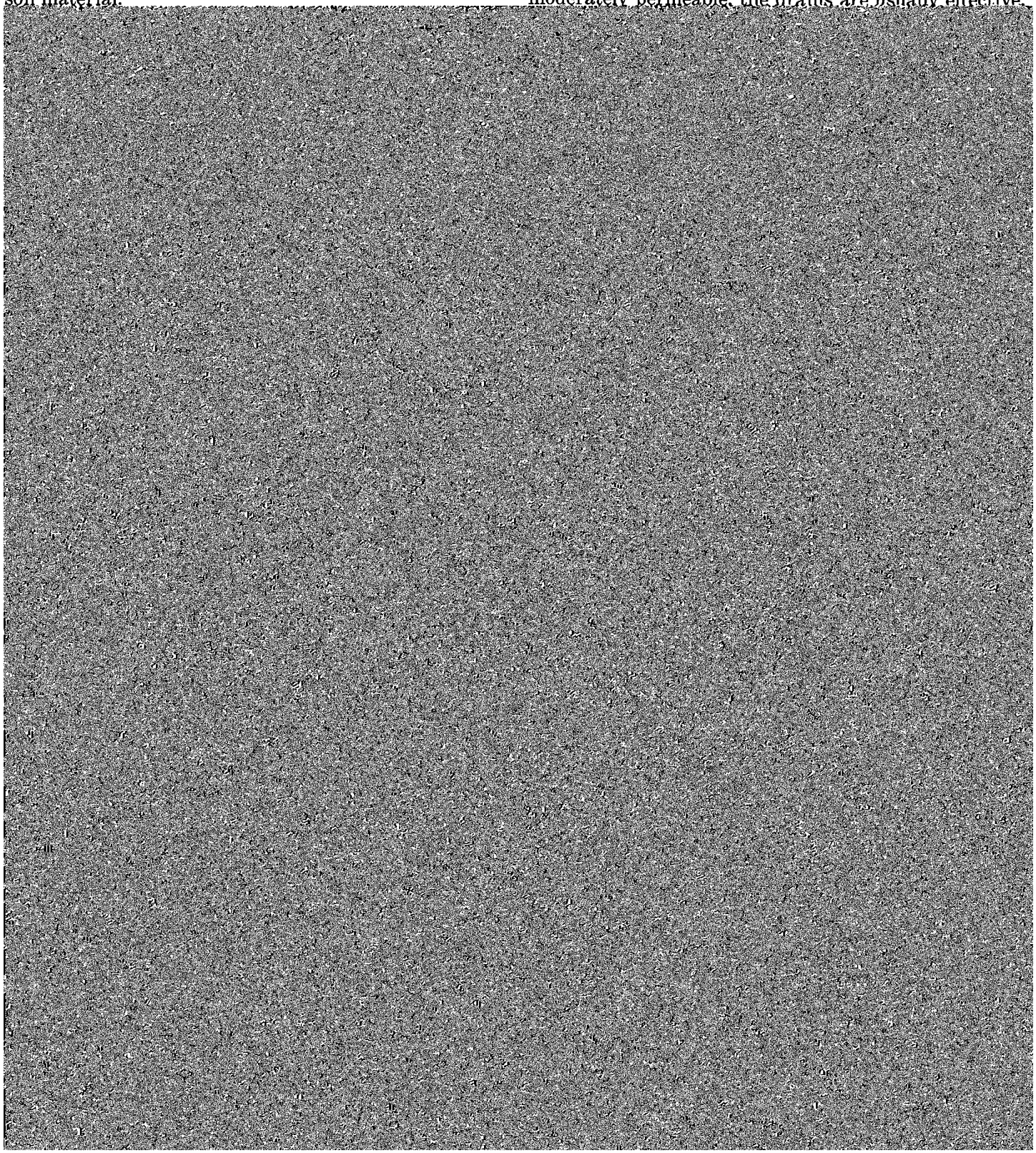
Gravity soils occur on foot slopes in the southern

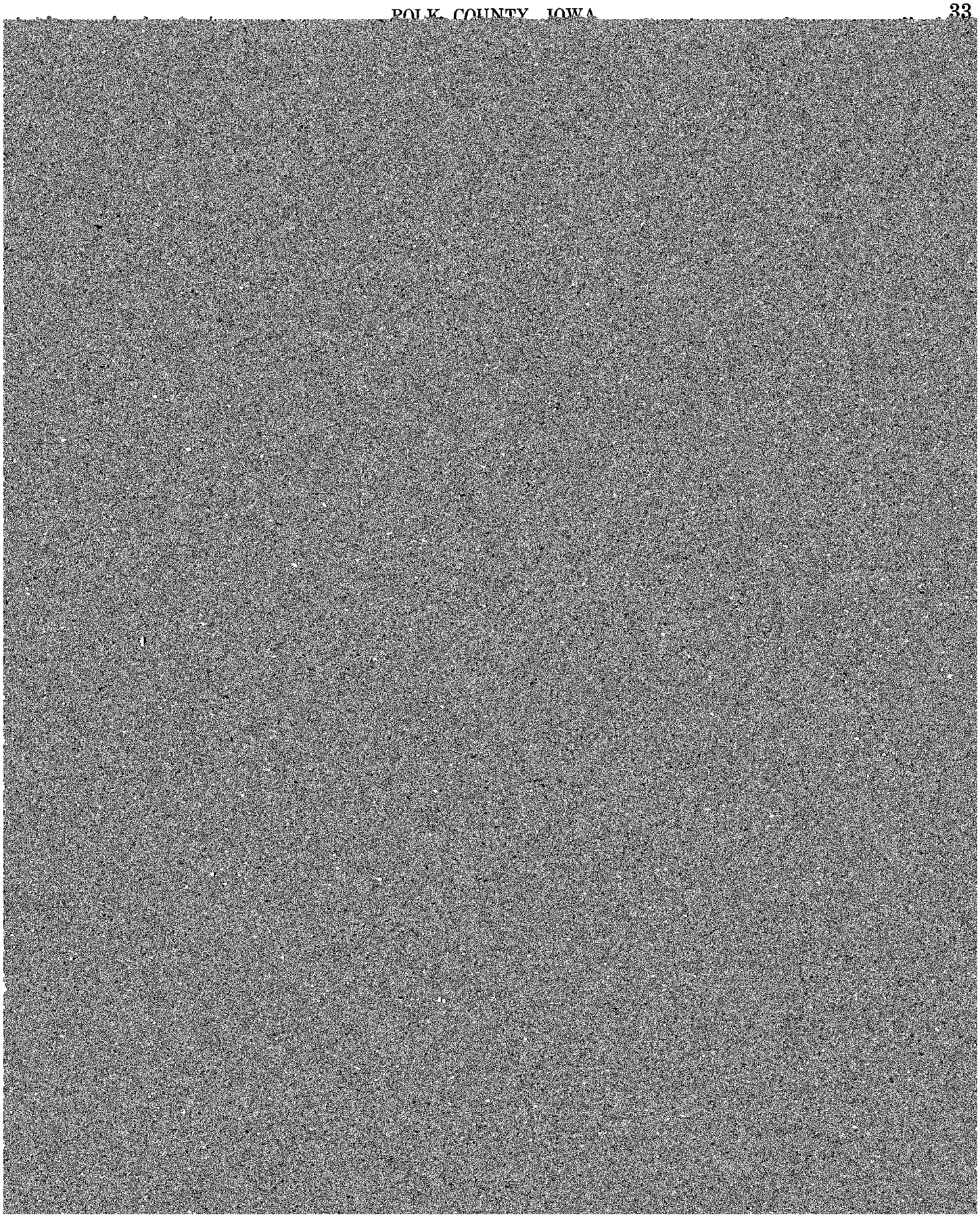
consin glacial outwash plains. Little organic matter has accumulated, either because the wind has removed some of the surface soil or deposited sand on the sur-



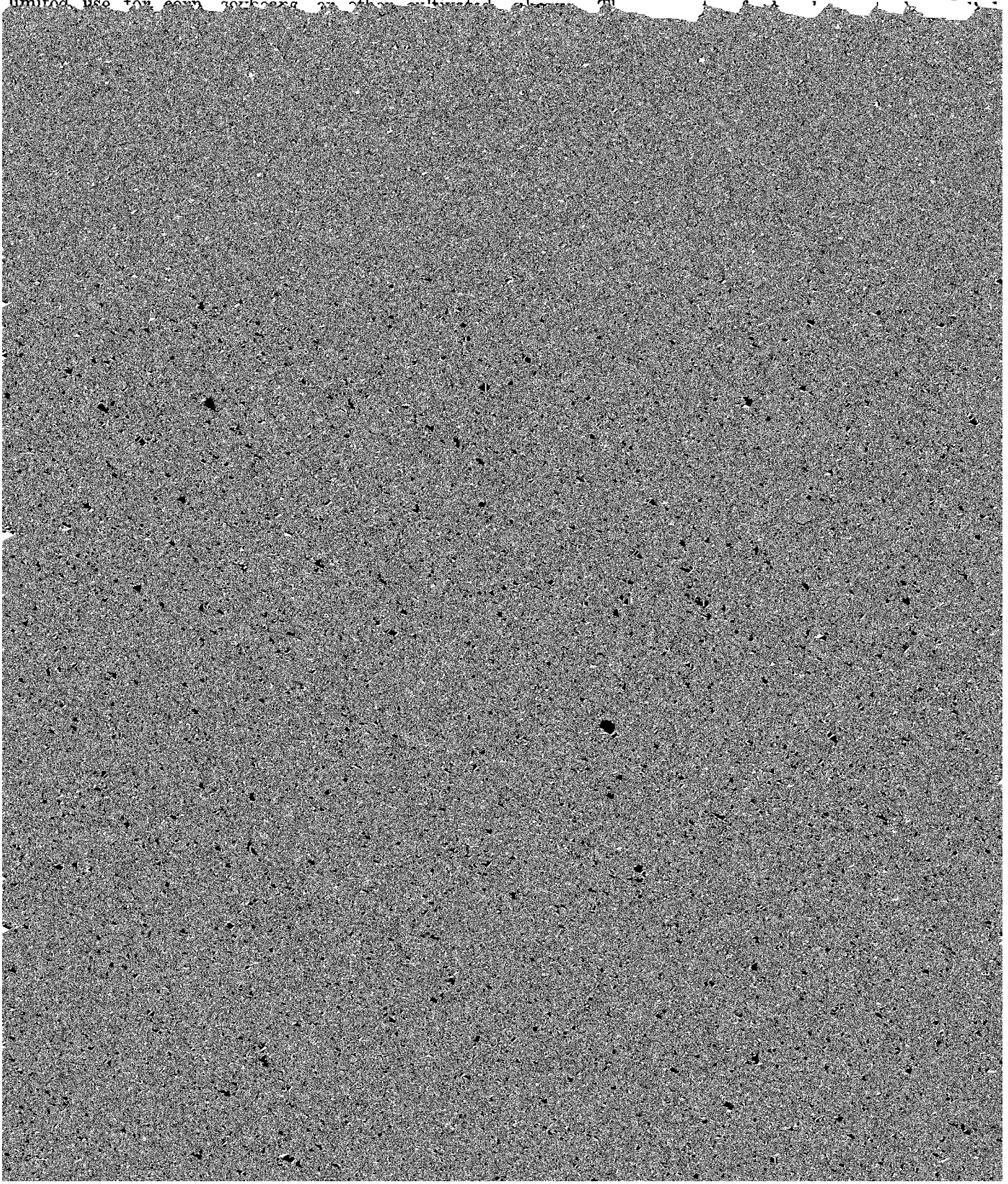
layer is generally less than 8 inches thick, the profile of this soil is similar to the representative profile of Hagener loamy fine sand. Included are some areas where the wind has deposited rather than removed soil material.

These soils are low in fertility. They do not supply enough potassium and phosphorus for corn and alfalfa. They are high in calcium carbonate. Most areas need artificial drainage. Since the soils are moderately permeable, tile drains are usually effective.





ture. Because of its channeled surface, this soil is of limited use for corn, soybeans, or other cultivated crops. The [illegible] is suitable. This soil is very low in available phos-



water concentrates, waterways should be kept in grass to help prevent gully erosion. (Capability subclass IIe.)

Judson silt loam, 5 to 9 percent slopes (JaC).—This soil is suitable for intensive cultivation in the larger areas, but it is usually cropped the same as adjacent soils. If it is cultivated, it may need tile to improve drainage or diversion terraces to help protect it from runoff from adjacent slopes. It should be cultivated on the contour to help control erosion. Where runoff water concentrates, waterways should be kept in grass to help prevent gullying. (Capability subclass IIIe.)

Kato series

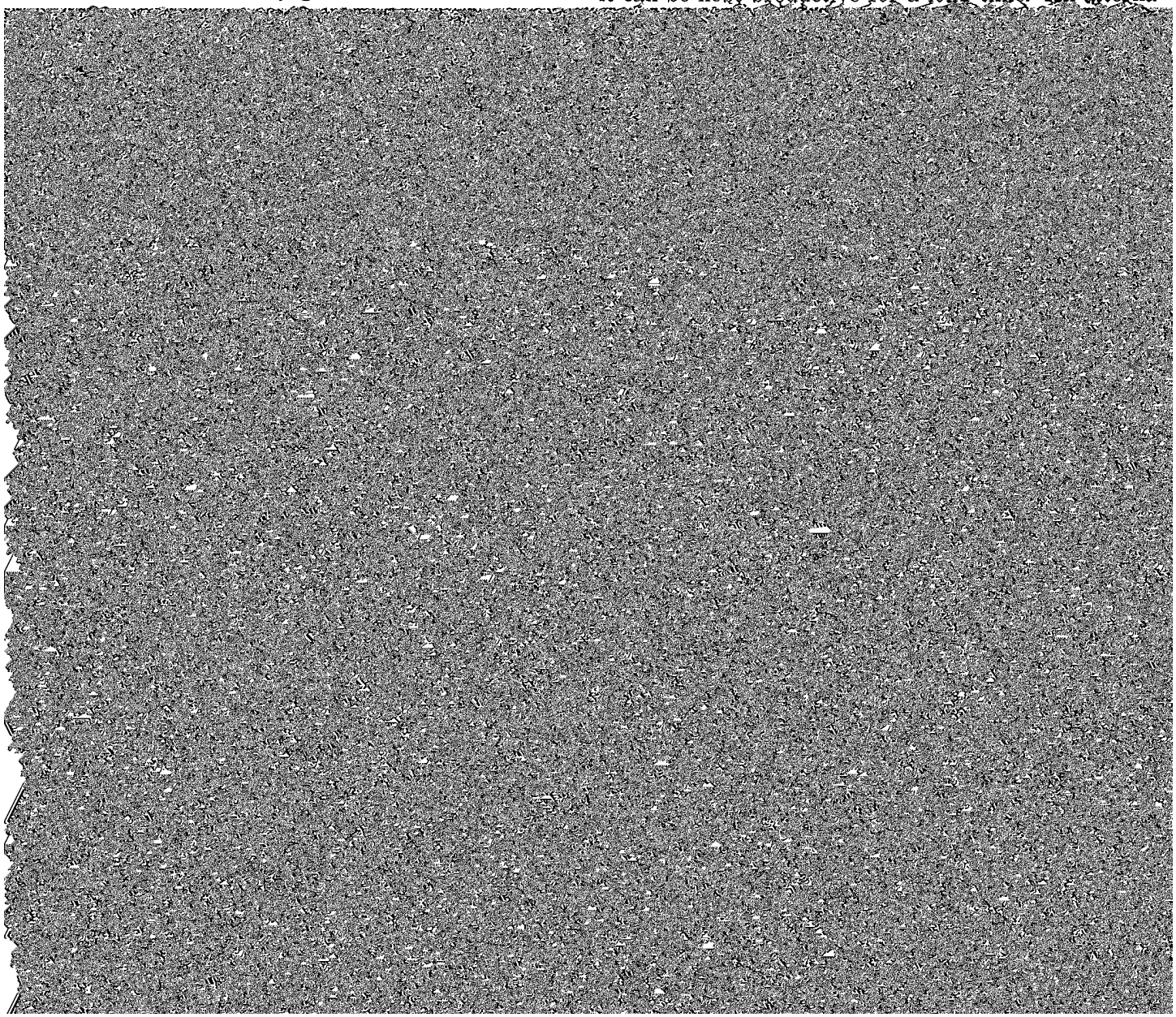
The soils of the Kato series are dark colored and imperfectly drained. They formed from gritty silt loam or loam over sand and gravel. Most of the parent material was laid down by glacial melt water. These

38 to 50 inches +, dark grayish-brown and reddish-yellow sand and gravel.

The texture of the surface soil and subsoil varies from loam to gritty slit loam. In some areas the texture of the subsoil is gritty silty clay loam or clay loam.

Kato loam, deep over sand and gravel, 1 to 3 percent slopes (KbA).—This soil is moderately to highly fertile. It is slightly wet in some areas, especially in those bordering the Marshan and other poorly drained soils. It has a somewhat lower water-holding capacity than the Nicollet soils but otherwise resembles them. Erosion is not a problem.

Under good management, this soil is highly productive of corn, soybeans, oats, and hay—the main crops grown. It is suited to a crop sequence in which corn is grown 2 years out of 3. If it is adequately fertilized, it can be kept productive for a long time. An alterna-



Ladoga silt loam, except that the surface and subsurface layers are thicker in some places.

If this soil is contoured, a rotation of corn-corn-oats-meadow is suitable. If it is not contoured, a rotation of corn-oats-meadow-meadow is suggested. (Capability subclass IIe.)

Ladoga silt loam, 5 to 9 percent slopes, moderately eroded (LaC2).—A rotation of corn-oats-meadow-meadow is suggested if this soil is contoured. For fields that are terraced, corn-corn-oats-meadow is a suitable rotation. (Capability subclass IIIe.)

Ladoga silt loam, 9 to 14 percent slopes, moderately eroded (LaD2).—In some areas the combined thickness of the two upper layers of this soil is only 4 to 7 inches. Corn-oats-meadow-meadow is a suitable rotation if this soil is stripcropped. For terraced fields, a rotation of corn-corn-oats-meadow-meadow is suggested. Alternative uses are hay and pasture. (Capability subclass IIIe.)

Ladoga silt loam, 14 to 20 percent slopes, moderately eroded (LaE2).—The surface and subsurface layers of this soil are only 4 to 6 inches thick. This soil is best suited to hay, pasture, or woodland. (Capability subclass IVe.)

Ladoga silt loam, 20 to 30 percent slopes, moderately eroded (LaF2).—This soil has a profile that has thinner surface and subsurface layers than the representative profile of Ladoga silt loam. The depth to the parent material is 6 to 12 inches less than in the representative profile. This soil is best suited to woodland or pasture. (Capability subclass VIIe.)

LADOGA SOILS, SEVERELY ERODED

Ladoga soils, 5 to 9 percent slopes, severely eroded (LbC3).—The surface and subsurface layers of this unit along with Clarion loam and other adjacent soils. The steeper areas are used for pasture.

LAKEVILLE SANDY LOAM

Sandy loam is the dominant type in the Lakeville series. Included with the sandy loams are spots of gravelly loam and coarse loam. Some areas of Storden and Dickinson soils are included. Generally, the Lakeville soils contain more gravel than the Dickinson soils and are less acid. Very small areas of Lakeville sandy loam are shown on the soil map by sand and gravel symbols. A representative profile of Lakeville sandy loam follows.

0 to 6 inches, very dark grayish-brown, very friable sandy loam.
6 to 22 inches, brown, very friable, sandy loam containing considerable gravel.
22 to 60 inches +, pale-brown, calcareous, loose gravel and sand.

Lakeville sandy loam, 2 to 5 percent slopes (LcB).—The dark surface layer of this soil is about 8 inches thick. A sequence of corn-oats-meadow is suggested. An alternative crop is permanent alfalfa. Many areas are so small that they must be managed with the adjoining soils. Yields are likely to be low in most years. Crop residues should be left on the surface to reduce wind erosion. (Capability subclass IIIs.)

Lakeville sandy loam, 5 to 9 percent slopes, moderately eroded (LcC2).—The profile of this soil is about like the representative profile of Lakeville sandy loam, though the dark-colored surface layer is normally less than 6 inches thick and is lacking in some areas.

If this soil is cultivated on the contour, a crop sequence of corn-oats-meadow-meadow is suitable. A

counts for the thinness of the surface layer. The parent material was wind-deposited fine sand and a very small amount of silt. Most of these materials were blown from the Des Moines River bottoms. The Lamont soils occur mainly in hilly areas on the eastern side of the Des Moines River, northwest of the city of Des Moines. Their slope range is 2 to 30 percent.

These soils are somewhat excessively drained and are very low in water-holding capacity. They are low in fertility. They are subject to wind and water erosion. Some of the gently sloping areas are used for corn, oats, and meadow although, even under good management, yields are low. The more strongly sloping areas are used for pasture or woodland.

LAMONT FINE SANDY LOAM

A representative profile of Lamont fine sandy loam follows.

0 to 4 inches, very dark grayish-brown, very friable fine sandy loam.
4 to 8 inches, grayish-brown, very friable fine sandy loam to loamy fine sand.
8 to 27 inches, yellowish-brown, friable fine sandy loam.
27 to 45 inches +, yellowish-brown, very friable to loose fine sandy loam to loamy fine sand.

The texture of the surface soil ranges from fine sandy loam to loamy fine sand. The texture of the

Lamont fine sandy loam, 20 to 30 percent slopes (LdF).—The profile of this soil is similar to the representative profile of Lamont fine sandy loam. Woodland is the most suitable use for this soil. (Capability subclass VIIs.)

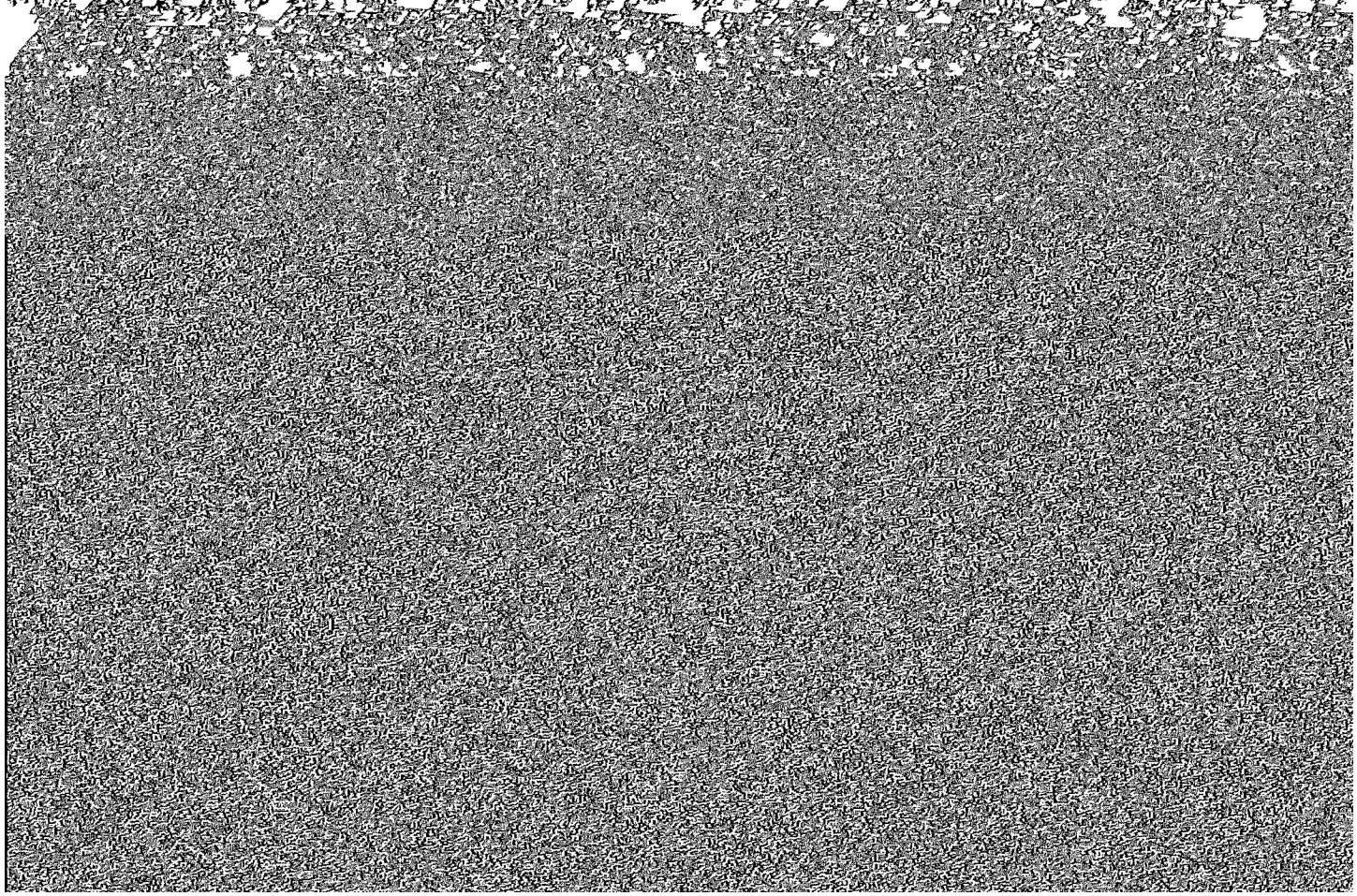
Lester series

The soils of the Lester series are moderately dark-colored, well-drained soils that formed from Cary glacial till of loam texture. They occur in the northern four-fifths of the county, in the uplands adjacent to the Des Moines and Skunk Rivers. In most areas they are adjacent to LeSueur, Clarion, or Hayden soils. The slope range is 0 to 40 percent. Centuries ago, the native vegetation was prairie grass; later trees encroached. Consequently, these soils have features of both prairie and forest soils.

These soils have good water-holding capacity and are moderately fertile. The upper layers of the profile are medium acid. Under good management, the gently sloping areas are highly productive of corn, oats, and meadow, which are the chief crops grown. The more strongly sloping areas are used for pasture and woodland.

LESTER LOAM

In some areas, Lester loams occur close to Crocker and Lamont soils. In these areas the texture of the surface soil is sandy loam. Spots of sandy loam are



If this soil is contoured, a rotation of corn-soybeans-corn-oats-meadow is suggested. If it is not contoured, corn-corn-oats-meadow-meadow is a suitable rotation. (Capability subclass IIe.)

Lester loam, 2 to 5 percent slopes, moderately eroded (LeB2).—The combined thickness of the upper two layers of this soil is only 5 to 8 inches. In some areas the yellowish-brown subsoil is exposed.

If this soil is contoured, a rotation of corn-soybeans-corn-oats-meadow is suggested. If it is not contoured, corn-corn-oats-meadow-meadow is a suitable rotation. (Capability subclass IIe.)

Lester loam, 5 to 9 percent slopes, moderately eroded (LeC2).—The combined thickness of the upper two layers of this soil is only 4 to 8 inches.

A rotation of corn-corn-oats-meadow-meadow is suitable if this soil is contoured. If it is not contoured, a rotation of corn-oats-meadow-meadow-meadow is suggested. Corn-corn-oats-meadow is a suitable rotation if the soil is terraced and heavily fertilized. (Capability subclass IIIe.)

Lester loam, 9 to 14 percent slopes, moderately eroded (LeD2).—The profile of this soil is similar to the representative profile of Lester loam.

If this soil is terraced, a rotation of corn-corn-oats-meadow-meadow is suitable. An alternative use is pasture. (Capability subclass IIIe.)

Lester loam, 14 to 20 percent slopes, moderately

The depth of leaching is less than in the profile described. It averages between 30 and 36 inches.

This unit is suitable for only limited cultivation. Its best use is probably permanent hay or pasture. (Capability subclass IVe.)

Lester-Colo complex

This complex consists mainly of Lester loam, 14 to 40 percent slopes, and Colo silty clay loam, 0 to 2 percent slopes. The Colo soil occurs on narrow bottom lands between steep slopes of Lester soil. Small areas of Hayden loam, Terril loam, and Huntsville silt loam are included.

The steep areas and the narrow bottom lands are so closely intermixed that most areas of this complex are used for pasture or woodland. Preventing erosion is the main management problem.

Lester-Colo complex, 0 to 20 percent slopes (LgE).—This complex is suited to hay, pasture, or woodland. (Capability subclass IVe.)

Lester-Colo complex, 0 to 40 percent slopes (LgF).—This complex is best suited to woodland. If it is used for pasture, grazing should be limited so that a good vegetative cover can be maintained to help prevent erosion. (Capability subclass VIIe.)

LeSueur series

The LeSueur series consists of moderately dark col-

A crop sequence of corn-corn-oats (green manure) is suitable for this soil if enough fertilizer is used, including plenty of nitrogen for the second year of corn. An alternative sequence is corn-soybeans-corn-oats-meadow. (Capability class I.)

Lindley series

The soils of the Lindley series are well drained and light colored and have clayey subsoils. They occur in the hilly uplands, mainly in the southeastern part of the county. The slope range is 9 to 40 percent.

These soils formed under forest. Partly because of that, they have a thin surface layer. The parent material was Kansan glacial till.

The Lindley soils are low in fertility. The upper layers are moderately acid. The water-holding capacity is good. Some areas are cropped to corn, oats, and meadow, but yields are not high, even under good management. The steeper areas are used chiefly for pasture or woodland. The erosion hazard is severe to extreme because the subsoil is fine textured and slowly [illegible]. The [illegible] thickness of the surface layer of thin. In many places it is only 4 to 8 feet thick over the shale bedrock.

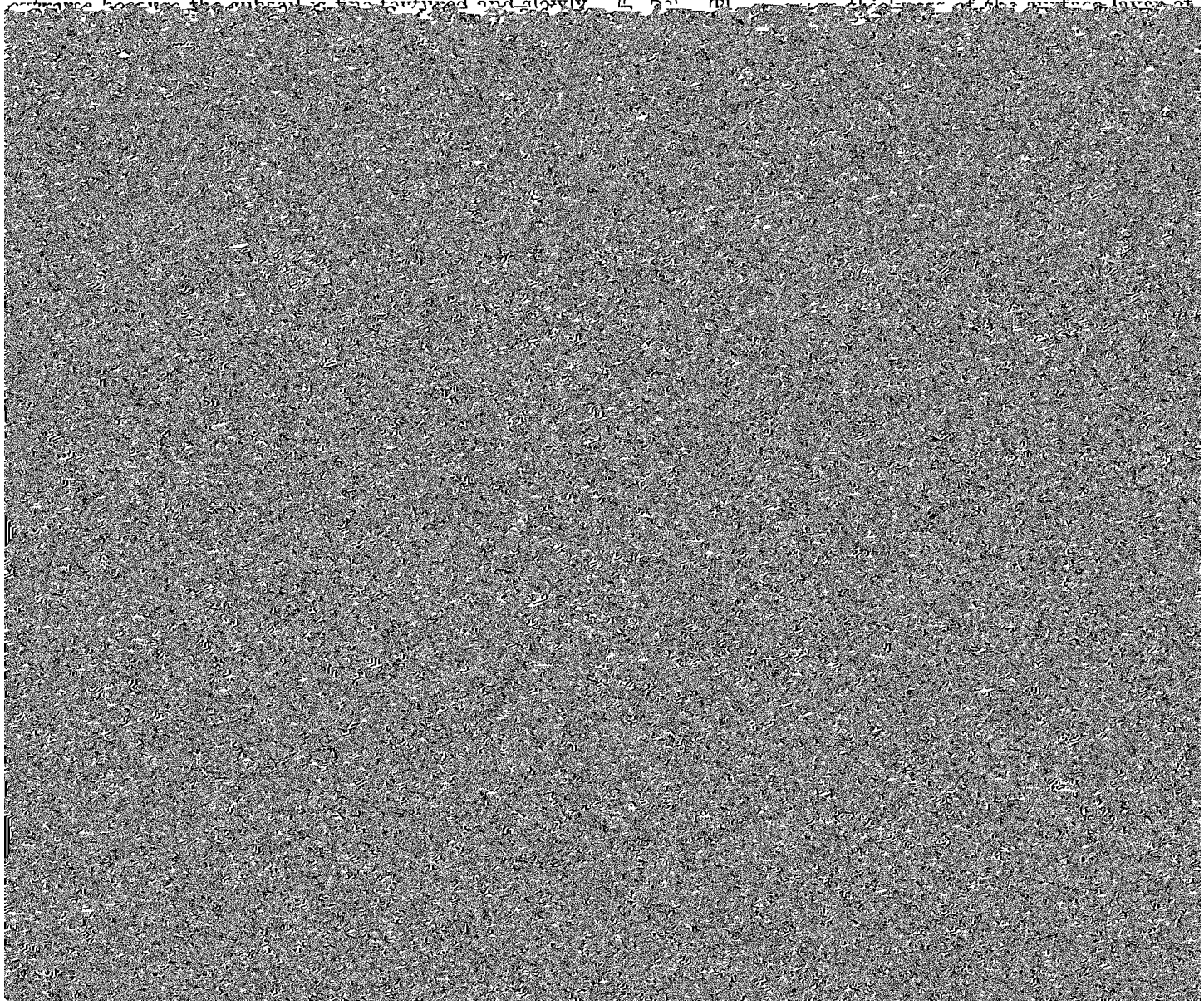
Lindley loam, 9 to 14 percent slopes, moderately eroded (LkD2).—The profile of this soil is similar to the representative profile of Lindley loam.

If this soil is needed for crops, it can be used for a small grain followed by several years of meadow. If it is contour stripcropped and well fertilized, corn can be grown once in 5 or 6 years, but long-term hay, pasture, or woodland are better uses. (Capability subclass IVe.)

Lindley loam, 14 to 20 percent slopes, moderately eroded (LkE2).—The profile of this soil is similar to the representative profile of Lindley loam, except that the subsoil is generally clay loam rather than gritty silty clay. Long-term pasture or woodland are suitable uses. (Capability subclass VIe.)

LINDLEY SOILS, ERODED

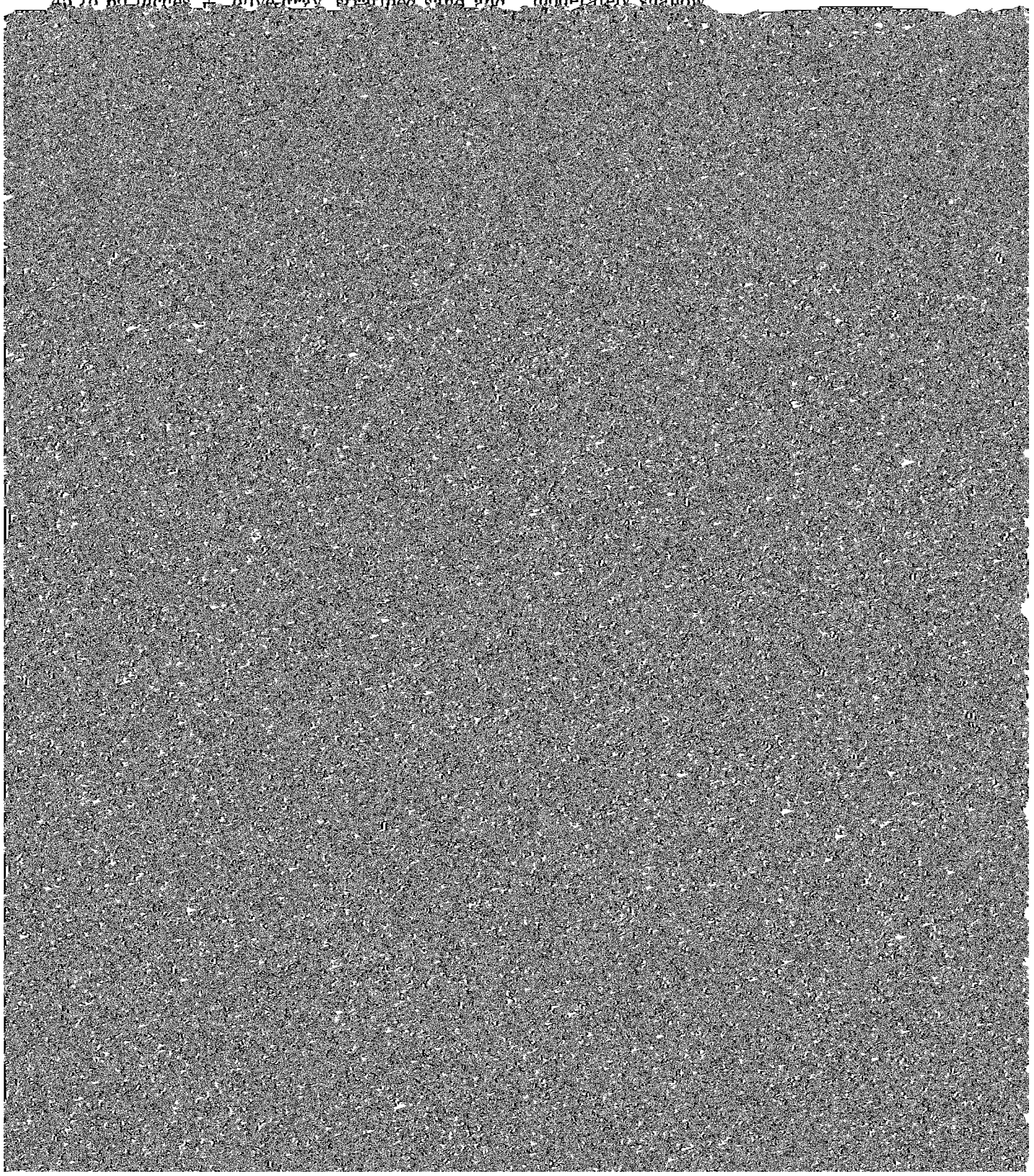
Lindley soils, 9 to 14 percent slopes, severely eroded [illegible]. The [illegible] thickness of the surface layer of



32 to 45 inches, olive-gray, slightly firm to firm silty clay loam; generally calcareous.
45 to 60 inches +, olive-gray, stratified sand and

MUCK

The following profile is representative of Muck, moderately shallow



Muscatine silt loam, 1 to 3 percent slopes (MeA).—This soil can be cropped intensively and still be kept productive if it is adequately fertilized. If corn is grown 2 years out of 3, extra nitrogen is needed. A suitable crop sequence for less intensive use is corn-corn-oats-meadow. If extra nitrogen fertilizer is not available for the second year of corn, a sequence of corn-oats-meadow can be used. (Capability class I.)

Nicollet series

The Nicollet series consists of dark-colored soils that developed from friable, calcareous loam till deposited by the Cary glacier. These soils formed under prairie vegetation. They are moderately well drained to imperfectly drained.

Nicollet soils occur on uplands in the northern four-fifths of the county, generally adjacent to or between the well-drained Clarion and the poorly drained Webster soils (page 7).

creeks. They are subject to flooding, and each flood deposits fresh sediment.

These soils are moderately fertile. Under good management, if they are not too frequently or severely flooded, they are highly productive of corn and soybeans. Use of individual areas depends on the overflow hazard. Many areas need protection from flooding. In some areas, small levees or dikes have been built.

NODAWAY SILT LOAM

A representative profile of Nodaway silt loam follows.

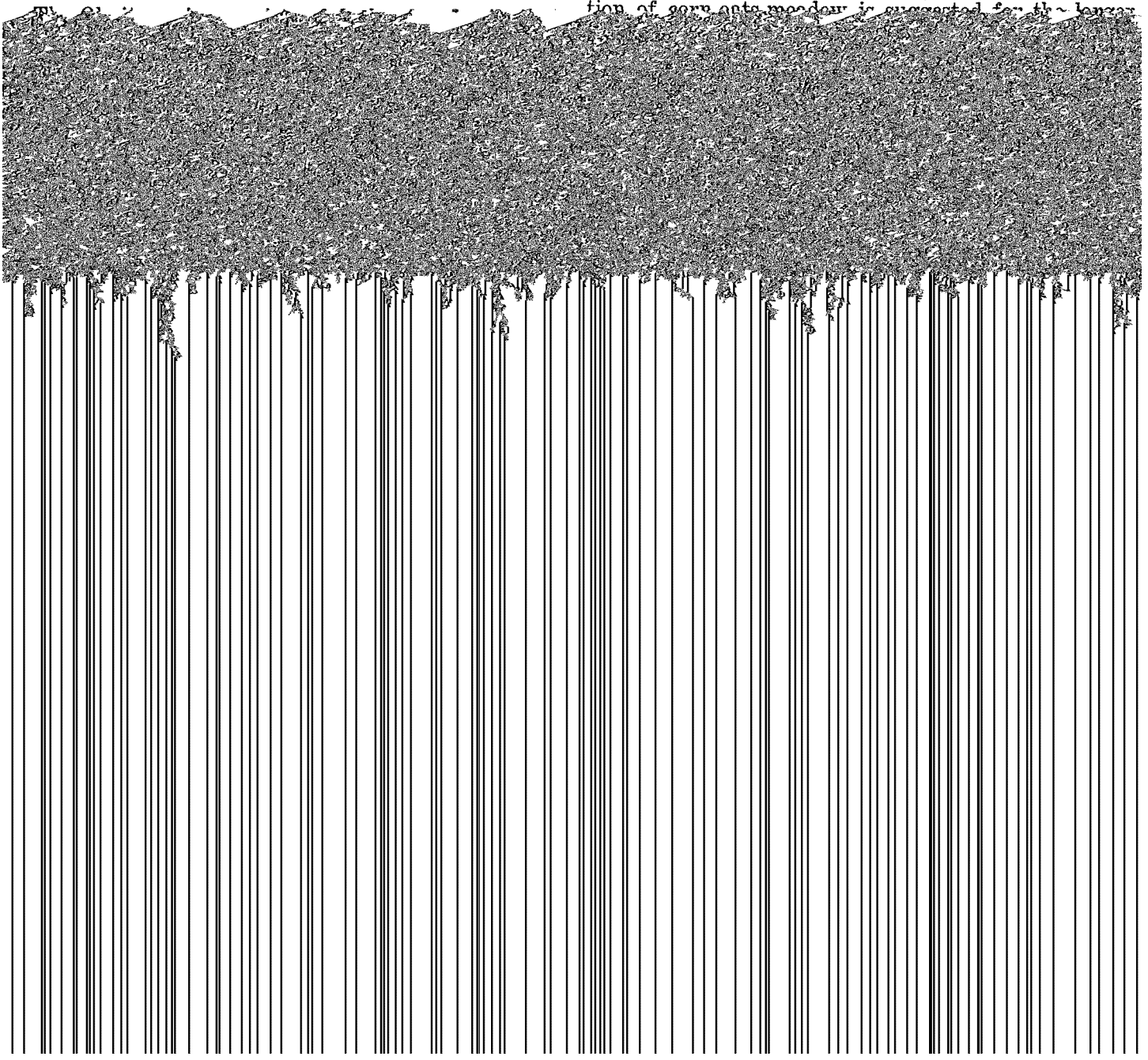
0 to 40 inches, dark grayish-brown, friable silt loam.
40 to 60 inches, black, slightly firm silty clay loam.

The texture ranges from loam to friable silty clay loam, though gritty silt loam is dominant. Lenses and

line. In a few areas the surface layer is slightly calcareous.

Okoboji silt loam (Oa).—This soil occurs mostly in small areas that cannot be cropped separately from the surrounding soils. It can be used and managed in about the same way as the Nicollet and Webster soils, with which it is associated on the landscape. If it can be adequately drained, it is suited to an intensive crop sequence, such as corn for 2 years, followed by oats seeded with a legume for green manure. It is poorly suited to legume meadows because winterkilling is common. (Capability subclass IIIw.)

Olmitz series



cropped intensively, it has a slight erosion hazard. (Capability subclass IIIe.)

OLMITZ SANDY LOAM

The profile of Olmitz sandy loam is sandier throughout than the representative profile of Olmitz loam.

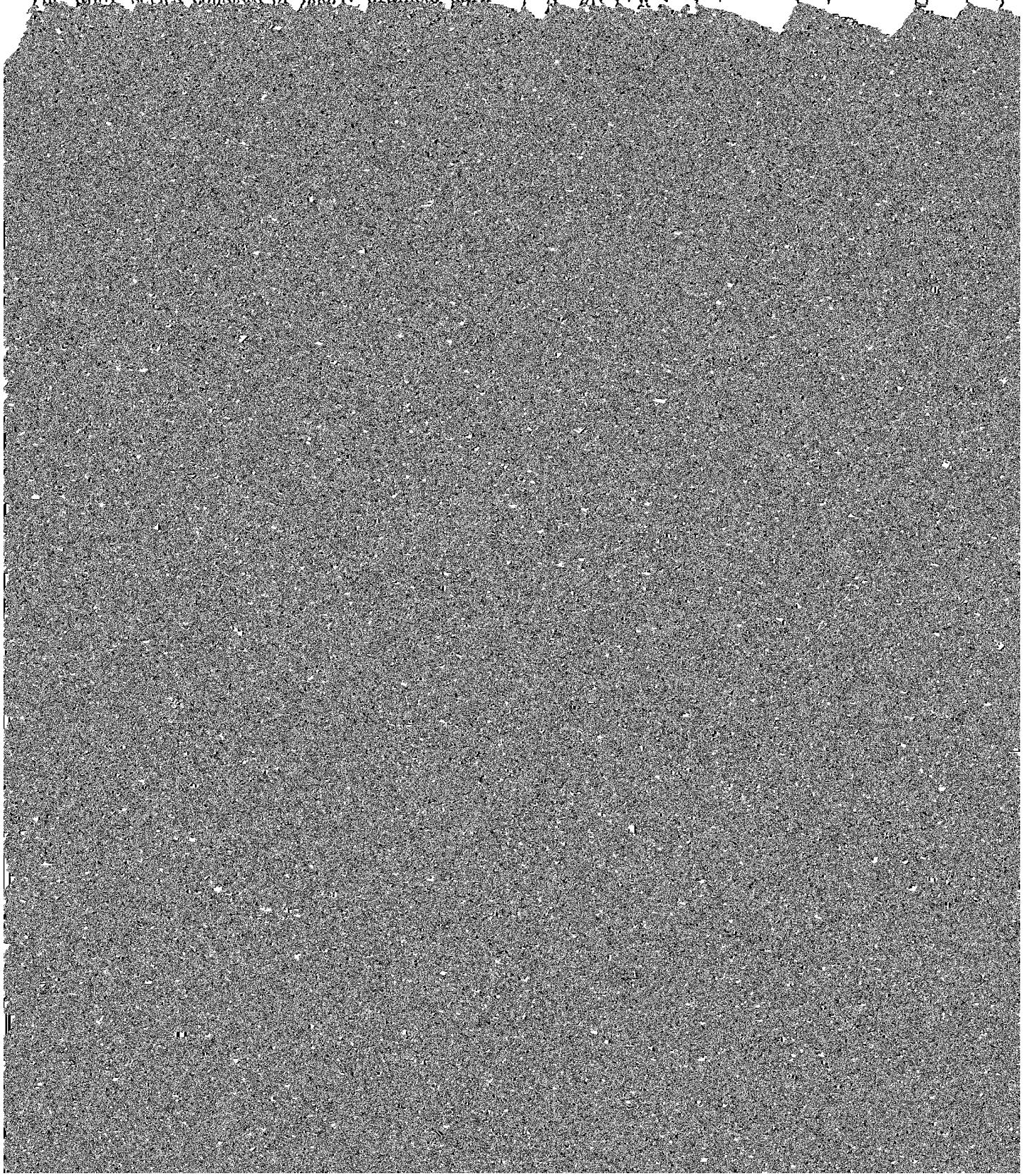
Olmitz sandy loam, 0 to 2 percent slopes (OcA).—This soil has a lighter colored and thinner surface layer than the Olmitz loams and a less well developed subsoil. It may be wet late in spring because of runoff from upland slopes. It is low in fertility and has a lower moisture-holding capacity than Olmitz loams.

Most of this soil occurs in small areas and is commonly cropped along with the adjacent soils. A rotation of corn, oats, meadow is suggested for the longer

Rolfe series

The Rolfe series consists of poorly drained, dark-

feet of the surface. In addition to the problems of wetness and possible difficulties with tile drainage due



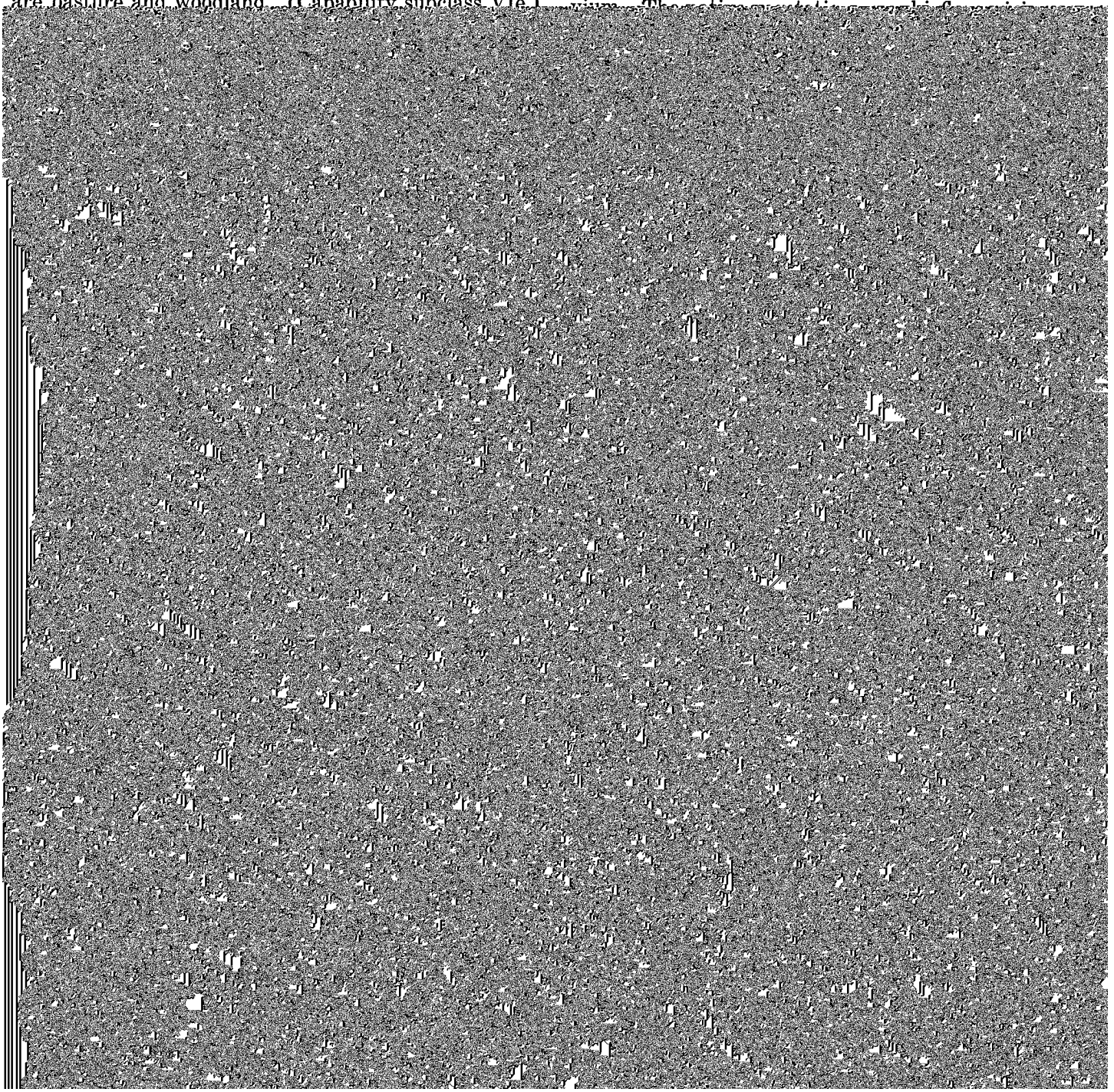
Runnells silt loam, 9 to 14 percent slopes, moderately eroded (RdD2).—This soil is suitable for only limited cultivation. It is better suited to permanent hay or pasture than to cultivated crops. (Capability subclass IVe.)

Runnells silt loam, 14 to 20 percent slopes, moderately eroded (RdE2).—The surface layer of this soil is a little thinner than that in the representative profile of Runnells silt loam. However, included are some uneroded tree-covered areas in which the surface layer is 8 to 12 inches thick. The most suitable uses for this soil are pasture and woodland. (Capability subclass VIe.)

vation because it is so droughty. It is best suited to hay or pasture. (Capability subclass IIIs.)

Saylor series

The Saylor series consists of dark-colored sandy soils that are moderately well drained to imperfectly drained. These soils have slopes of 0 to 2 percent. They occur on glacial outwash and stream terraces, mainly along the Des Moines River. They are commonly associated with Dickinson sandy loam, bench position. The parent material was sandy glacial outwash or sandy allu-



Most of these soils occur where the Wisconsin loess was deposited on Kansan glacial till. In a few areas, mapped as bench-position phases, the loess was deposited on old alluvial terraces. The native vegetation was grass.

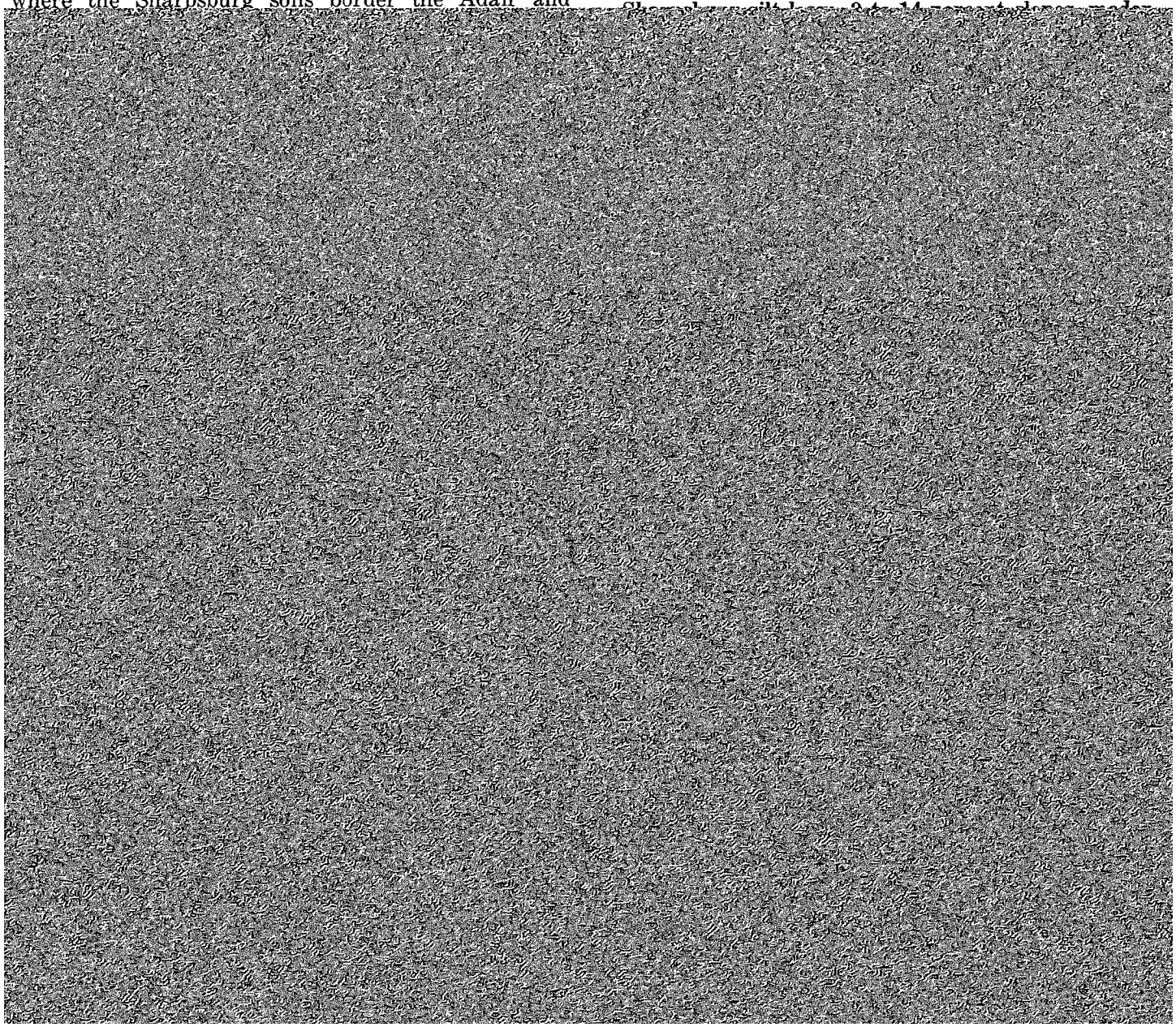
Sharpsburg soils are moderately to moderately slowly permeable and have good water-holding capacity. They are moderately to highly fertile. The upper layers are slightly acid to medium acid. The gently sloping phases are used intensively for corn, soybeans, oats, and meadow. Under good management, high yields are obtained. The steeper phases are also cropped, but they are used less often for row crops and more often for meadow; some areas are used for permanent pasture. Erosion is a severe hazard on the steeper phases. Sometimes there is seepage in areas where the Sharpsburg soils border the Adair and

colored surface layer is commonly only 6 to 9 inches thick.

If this soil is contoured, it can be used for a crop sequence of corn-corn-oats-meadow-meadow and still be kept at maximum productivity. If terraced and heavily fertilized, this soil is suitable for a rotation of corn-corn-oats-meadow. (Capability subclass IIIe.)

Sharpsburg silt loam, 5 to 9 percent slopes, moderately eroded (ScC2).—The dark surface layer of this soil is only about 4 to 8 inches thick.

If this soil is contoured, a crop sequence of corn-corn-oats-meadow-meadow will give maximum production and keep erosion losses at a minimum. If the soil is terraced and heavily fertilized, a rotation of corn-corn-oats-meadow is suitable. (Capability subclass IIIe.)



SHELBY LOAM

A representative profile of Shelby loam follows.

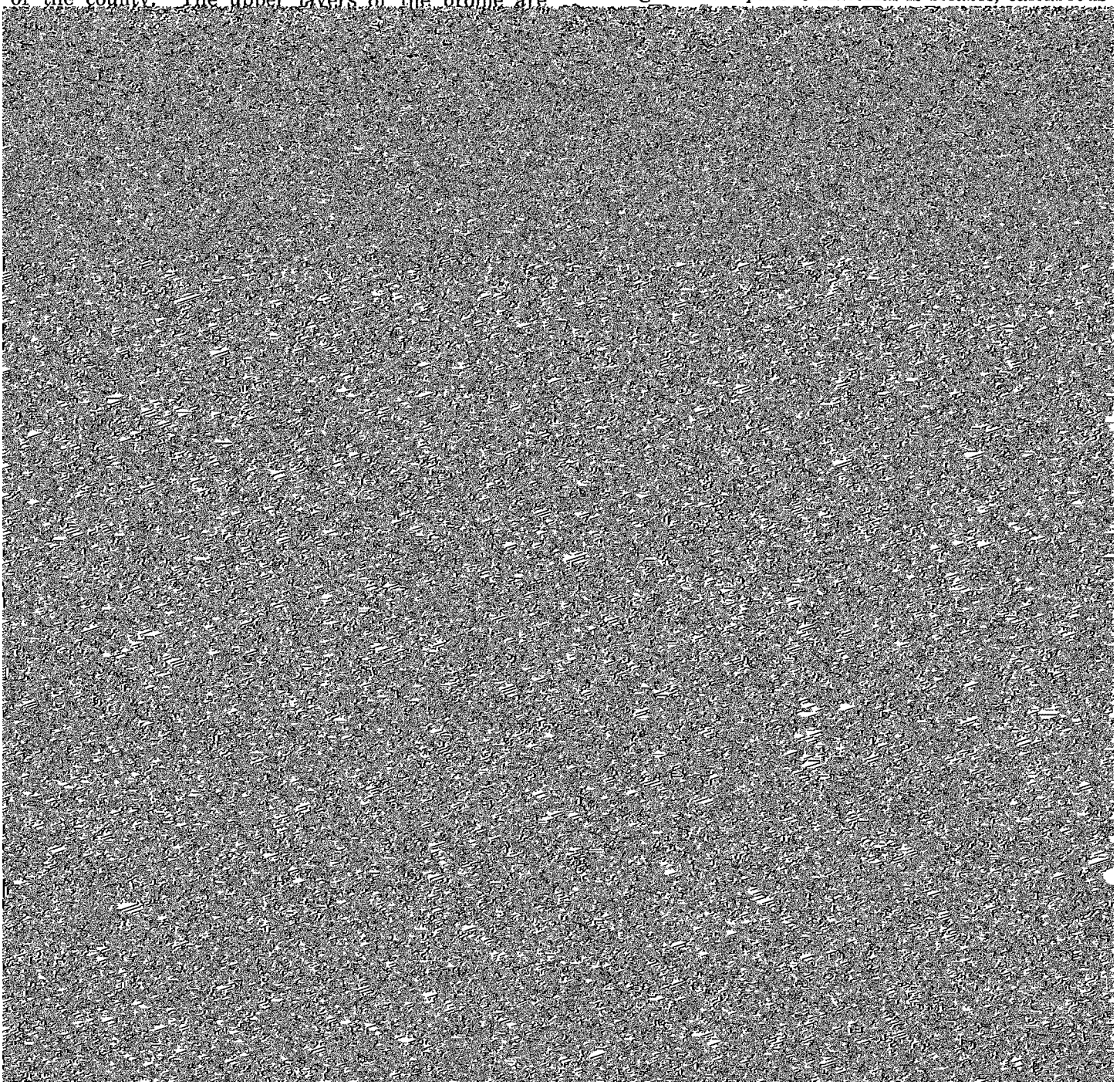
0 to 7 inches, very dark grayish-brown, friable loam.
7 to 14 inches, dark-brown, firm loam.
14 to 30 inches, brown to yellowish-brown, firm clay loam.
30 to 50 inches +, yellowish-brown, mottled with strong brown and light brownish gray, slightly firm clay loam to heavy loam.

The Shelby soils are among the more variable soils of the county. The upper layers of the profile are

Storden series

The Storden series consists of dark-colored, well-drained, calcareous soils that developed from Cary glacial till of loam texture. These soils occur on the uplands in the northern four-fifths of the county. They have slopes of 3 to 40 percent. The slopes are short, irregular, and generally steep. Many small areas are included with Clarion soils. Where Storden soils border Lakeville soils, there are some gravelly and sandy inclusions. Figure 7 shows how Storden soils occur on the landscape.

The glacial-till parent material is friable, calcareous



ridges, in association with gently sloping Clarion and Nicollet soils.

If this unit is contoured, corn-oats-meadow-meadow is a suitable rotation. If this unit is terraced, a rotation of corn-corn-oats-meadow is suggested. Alternative uses are hay and pasture. (Capability subclass IIIe.)

Storden soils, 9 to 14 percent slopes, severely eroded (ShD3).—The profile of this unit is like the representative profile of Storden loam, except that the surface layer is only 2 to 6 inches thick.

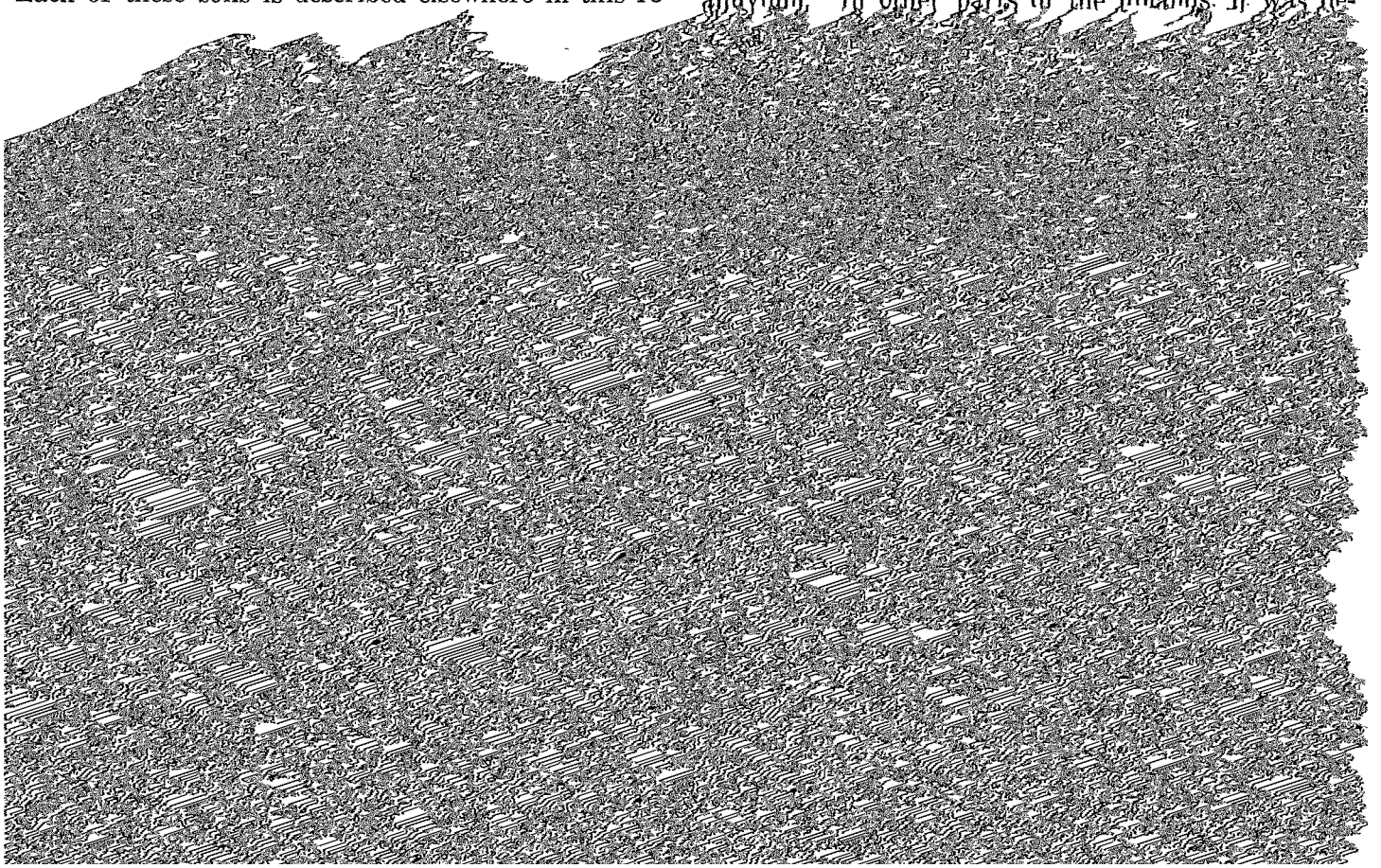
This unit is best suited to pasture or hay. If it is terraced, a rotation of corn-oats-meadow is suitable. (Capability subclass IIIe.)

Storden soils, 14 to 20 percent slopes, severely eroded (ShE3).—The profile of this unit is like the representative profile, except that the dark surface layer is only 2 to 6 inches thick. Included are some areas where all of the original surface layer has been lost through erosion.

This unit is best suited to permanent hay or pasture. (Capability subclass IVe.)

Storden-Colo complex

This complex occurs along drainageways in the northern four-fifths of the county. It consists mainly of Colo silty clay loam on narrow bottom lands surrounded by steep Storden soils. Smaller acreages of moderately steep Clarion and Terril soils are included. Each of these soils is described elsewhere in this re-



The productivity is low. The slope range is 5 to 20 percent.

Storden-Lakeville complex, 5 to 9 percent slopes, moderately eroded (SmC2).—The dark-colored surface layer of this unit is variable, but ordinarily it is 4 to 8 inches thick. In some areas, little or none of the original surface soil remains.

Some of this unit is in fields of Clarion soils and is cropped along with them. If this unit is contoured, a suggested rotation is corn-oats-meadow-meadow. If the unit is terraced, a rotation of corn-oats-meadow is suggested. Pasture is possibly the best use. (Capability subclass IIIs.)

Storden-Lakeville complex, 9 to 14 percent slopes, moderately eroded (SmD2).—The soils of this unit are best suited to pasture. (Capability subclass IVs.)

Storden-Lakeville complex, 14 to 20 percent slopes, moderately eroded (SmE2).—This unit is best suited to long-term pasture. (Capability subclass VIs.)

Stronghurst series

The Stronghurst series consists of imperfectly drained, light-colored soils that developed from loess of Wisconsin age. These soils have slopes of 0 to 2 percent. They occur mainly on the uplands in the southeastern part of the county. A few areas that are on natural terraces along some of the streams are mapped as Stronghurst silt loam, bench position. On the natural terraces, the loess was deposited over old alluvium. In other parts of the uplands, it was de-

minimum. Extra nitrogen is needed for the second year of corn. (Capability class I.)

Stronghurst silt loam, bench position (So).—This soil occurs on loess-covered stream terraces. It is underlain at a depth of 5 feet by medium-textured alluvium. A crop sequence of corn-corn-oats-meadow should give maximum long-time production, provided extra nitrogen is applied for the second year of corn. (Capability class I.)

Tama series

The Tama series consists of dark-colored, well-drained soils that developed from loess. These soils have slopes of 0 to 14 percent. They occur in the hilly area in the southeastern part of the county and are associated with Muscatine, Downs, and Fayette soils (fig. 8). The native vegetation was grass.

The Tama soils have good water-holding capacity and are moderately to highly fertile. The upper layers of the profile are medium acid. Many of the stronger slopes have lost much of the original dark-colored surface layer through erosion. The nearly level and gently sloping areas are used for corn, oats, and meadow. Under good management, high yields are

soil is only about 4 to 8 inches thick. If this soil is contoured or terraced and heavily fertilized, a crop sequence of corn-soybeans-corn-oats-meadow is suggested. Without these practices, a rotation of corn-corn-oats-meadow is suitable. (Capability subclass IIe.)

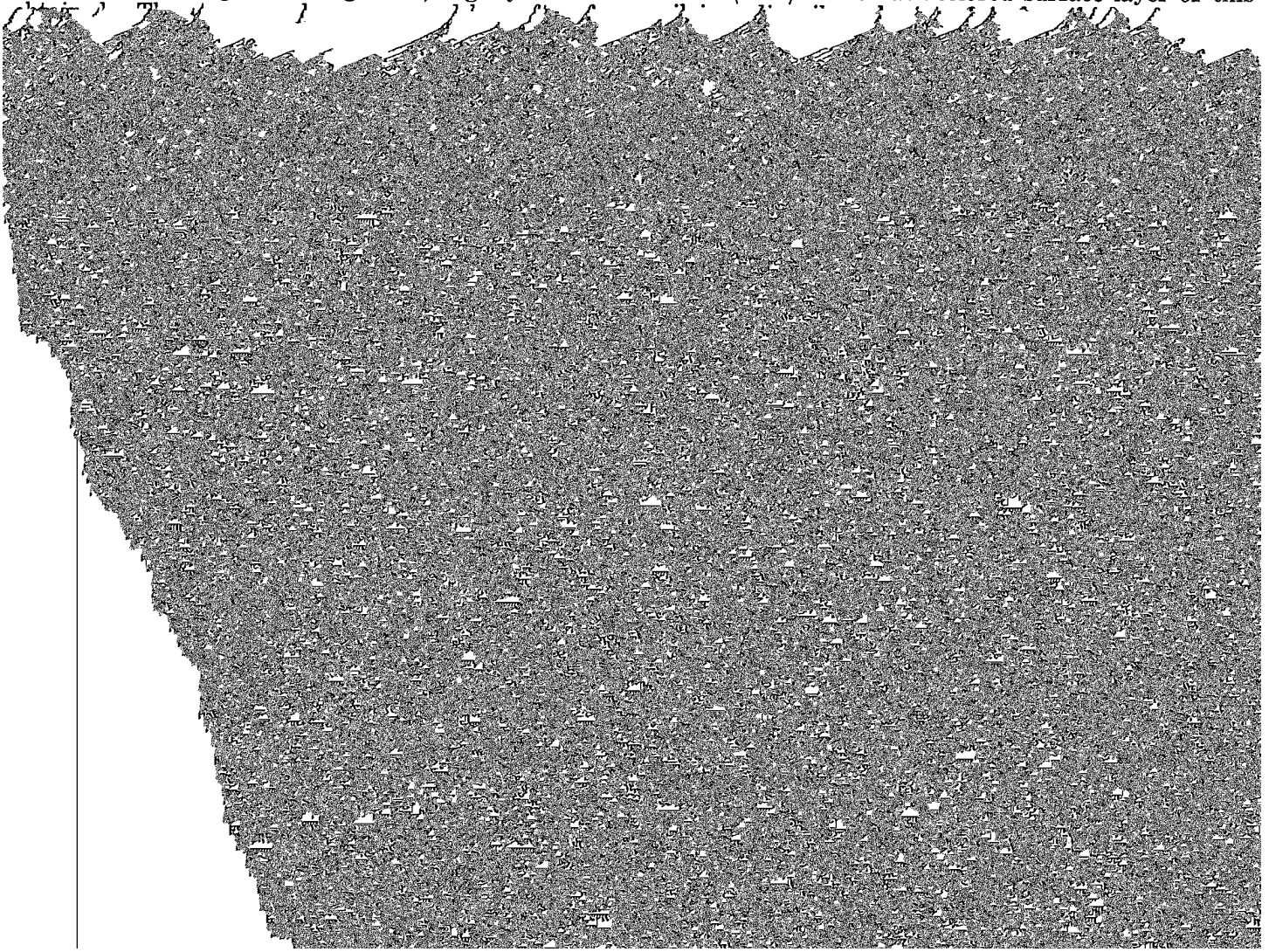
Tama silt loam, 5 to 9 percent slopes (TaC).—In this soil, the dark-colored surface layer is a few inches thinner than in the representative profile of Tama silt loam.

If this soil is contoured, a crop sequence of corn-corn-oats-meadow-meadow is suggested. If it is terraced and heavily fertilized, corn-corn-oats-meadow is a suggested rotation. (Capability subclass IIIe.)

Tama silt loam, 5 to 9 percent slopes, moderately eroded (TaC2).—The dark-colored surface layer of this soil is only 4 to 8 inches thick.

If this soil is contoured, corn-corn-oats-meadow-meadow is a suggested rotation. If this soil is terraced and large amounts of fertilizer are used, a rotation of corn-corn-oats-meadow is suitable. (Capability subclass IIIe.)

Tama silt loam, 9 to 14 percent slopes, moderately eroded (TaD2).—The dark-colored surface layer of this



areas are mapped as part of the Colo-Terril complex or as inclusions in the Storden-Colo complex.

Terril soils are normally well drained to moderately well drained, but are somewhat poorly drained in the nearly level areas. They have good water-holding capacity and are highly fertile. The upper layers of the profile are slightly acid. These soils are highly productive of row crops and grain crops, as well as of meadow and pasture. Erosion is a problem on the steeper slopes. The gentle slopes sometimes receive some runoff and sediment from the adjacent higher lying soils. Where water concentrates, gully erosion is a problem. The larger individual areas are used intensively for row crops and grain crops, but small areas adjacent to steeper areas are used for pasture.

TERRIL LOAM

A representative profile of Terril loam follows.

0 to 16 inches, very dark brown, friable loam.
16 to 30 inches, very dark grayish-brown, friable loam.
30 to 60 inches +, dark grayish-brown, friable loam mottled with yellowish brown.

The surface layer ranges from very dark brown to very dark grayish brown in color and from 15 to 25 inches in thickness. Generally the texture is loam throughout the profile, but it ranges from sandy loam, where these soils border the Ankeny soils, to clay loam, where they border the Colo soils.

Terril loam, 0 to 2 percent slopes (TcA).—This soil has a thicker and darker colored surface layer than the representative profile of Terril loam. Some areas tend ing slopes. If the soil is not contoured or protected by terraces, a crop sequence of corn-oats-meadow or corn-corn-oats-meadow-meadow is suggested. Waterways should be kept in sod to help control gullying. (Capability subclass IIIe.)

Wabash series

The Wabash series consists of dark-colored, poorly to very poorly drained soils that have very slow permeability. They occur in small areas on the bottom lands of the Skunk River and some of the smaller creeks in other parts of the county. Wabash soils are also mapped as part of the Wabash-Gravity-Nodaway complex. The slope range is 0 to 1 percent. The parent material is slack-water alluvium. The native vegetation was wet-prairie grass and some trees.

These soils are often too wet for crops. Because of the clayey subsoil, tile lines are not very practicable for improving drainage. A few areas are drained by surface ditches. Some of the lower lying areas receive runoff and floodwaters, which add to the wetness problem.

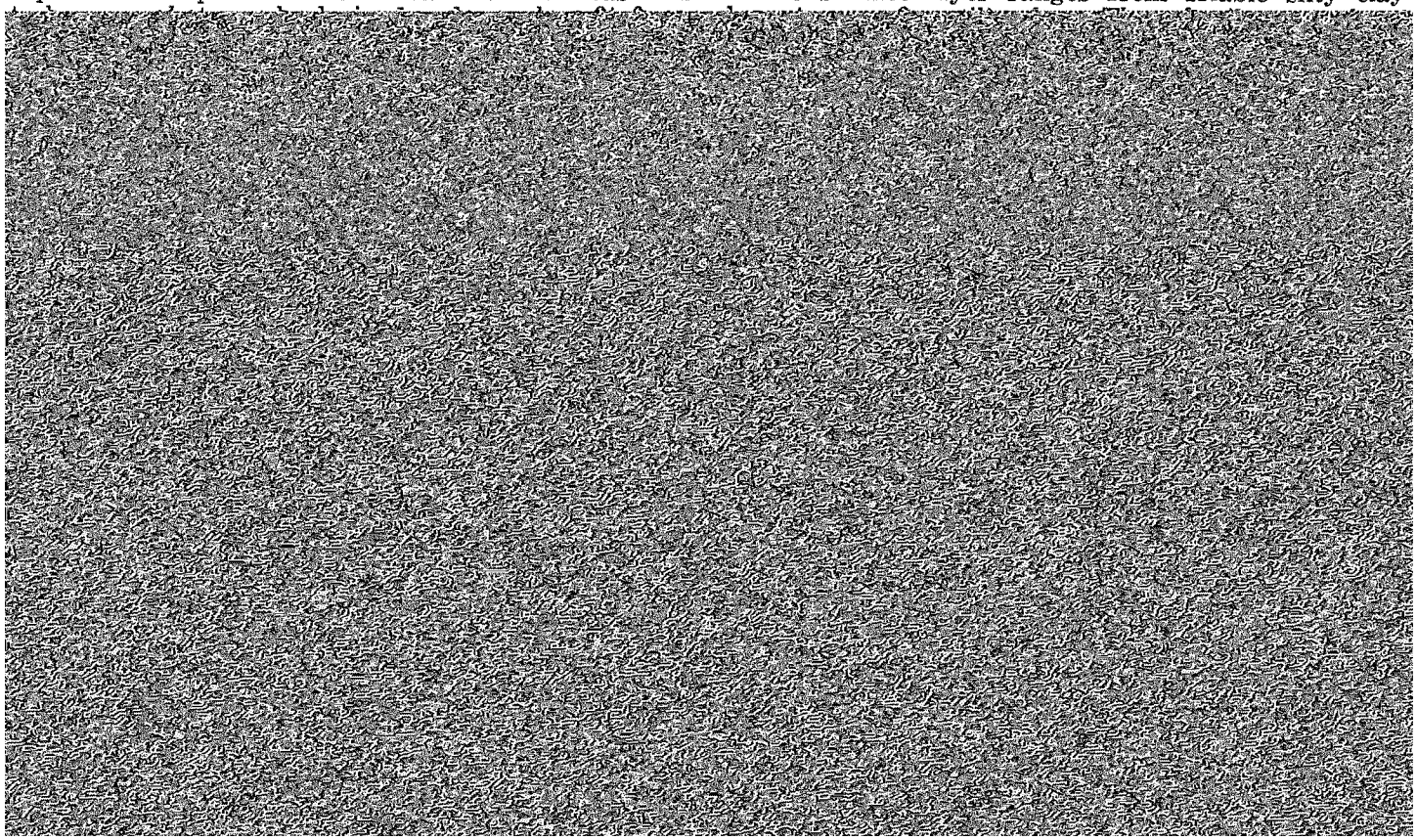
These soils are used for corn and soybeans in years that are not too wet. Another use is pasture.

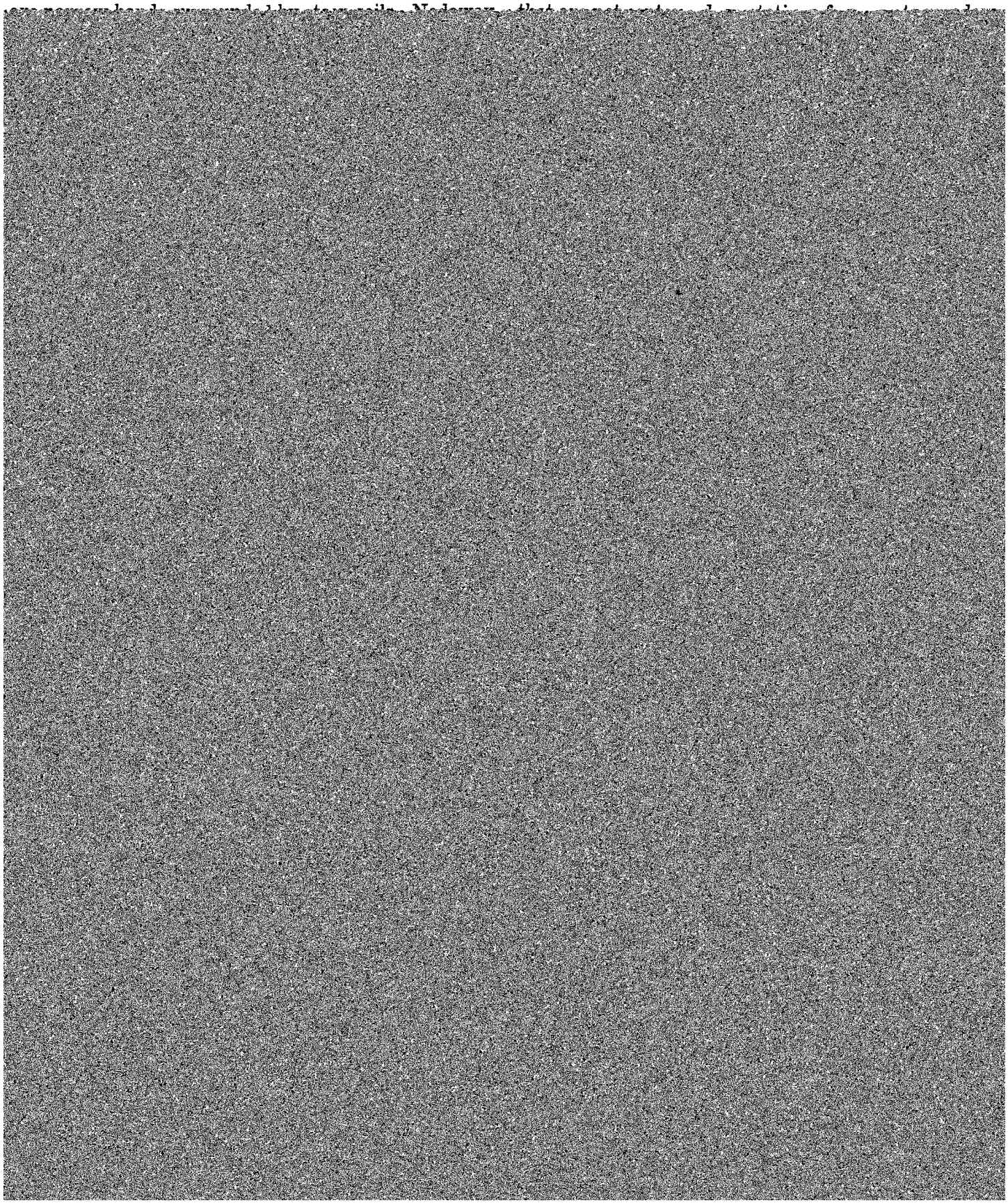
WABASH SILTY CLAY

A representative profile of Wabash silty clay follows.

0 to 14 inches, black, firm to very firm silty clay.
14 to 33 inches, dark-gray, very firm silty clay.
33 to 50 inches, dark-gray, very firm silty clay mottled with olive gray.

The surface layer ranges from friable silty clay





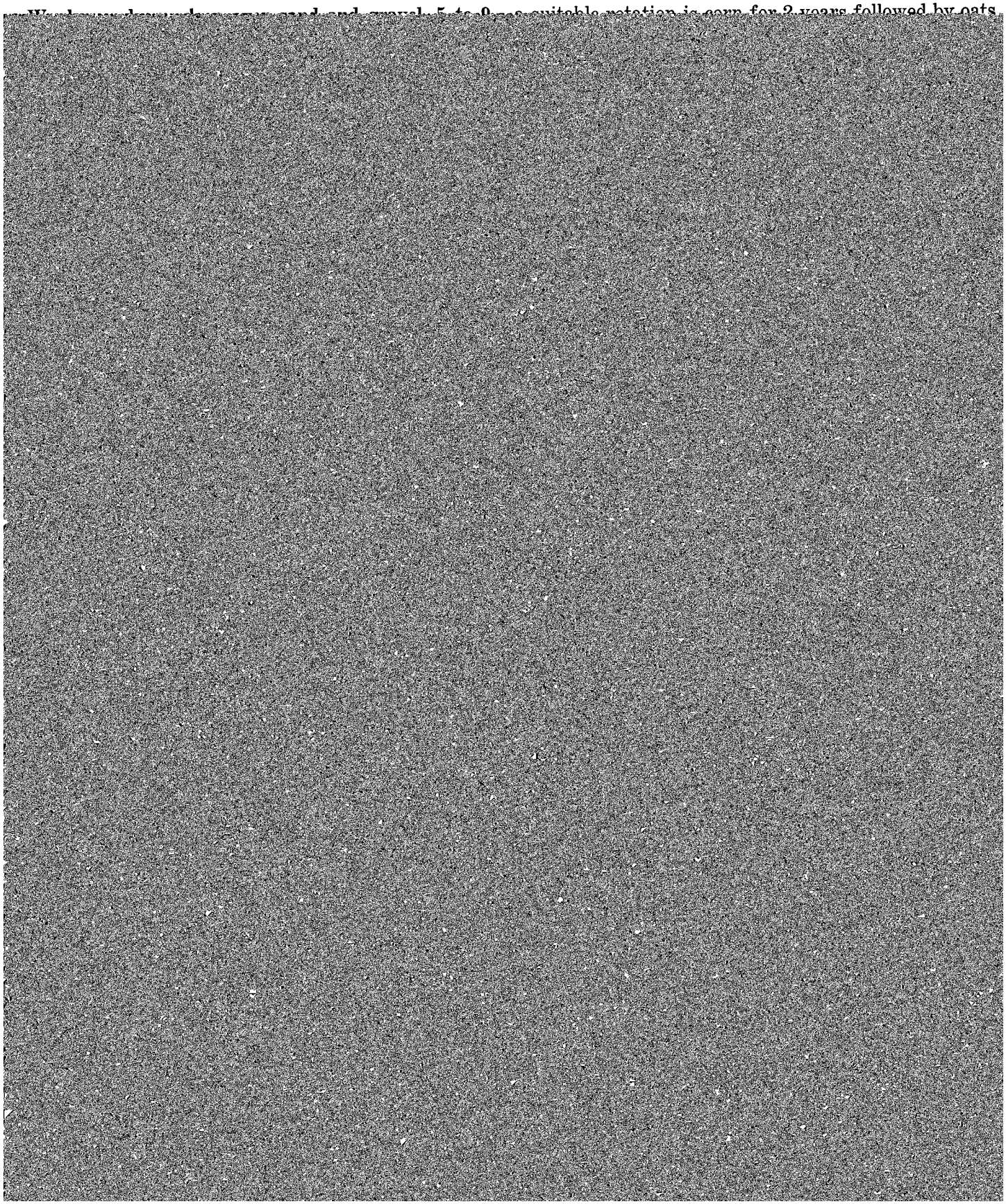


TABLE 3.—*Summary of major*

Soil	Slope range	Parent material, or substratum	Position on landscape	Native vegetation
	Percent			
Adair clay loam	5 to 14	Kansan glacial till	Uplands (lower slopes, coves	Prairie

characteristics of soil types

Dominant natural drainage [1]	Surface layer (A horizon, uneroded)	Subsoil (B horizon, if present)	Permeability of subsoil [2]
Intermediate	Very dark grayish-brown clay loam	Mottled dark grayish-brown and very dark gray silty clay or clay loam.	Very slow.
Good to poor	Variable	Variable	Variable.
Poor	Very dark grayish-brown loam; light brownish-gray subsurface layer.	Light olive-brown silty clay	Very slow.
Good	Very dark grayish-brown sandy loam	Dark-brown and brown sandy loam	Rapid.
Intermediate	Very dark gray silt loam; grayish subsurface layer.	Dark grayish-brown silty clay loam	Moderate.
Good	Very dark grayish-brown silt loam	Thin, brown silt loam, if present	Very slow to moderate.
Poor	Black silt loam; grayish subsurface layer.	Very dark gray silty clay	Very slow.
Good	Dark grayish-brown, loamy coarse sand.	Dark-brown, loamy coarse sand	Very rapid.
Intermediate	Very dark grayish-brown silt loam; grayish-brown subsurface layer.	Mottled dark grayish-brown silty clay loam.	Slow.
Intermediate	Grayish-brown silt loam mottled in lower part.	No B horizon	Moderate.
Good	Very dark brown loamy fine sand; dark-gray subsurface layer.	Yellowish-brown loamy fine sand	Very rapid.
Poor	Very dark gray silty clay loam	Mottled dark-gray or olive-gray silty clay.	Very slow.
Good	Very dark brown loam	Dark-brown loam	Moderate.
Good	Very dark brown silt loam	Dark-brown silt loam or loam	Moderate.
Intermediate	Very dark gray silty clay loam to silt loam.	Mottled dark grayish-brown silty clay loam.	Slow.
Poor	Black to very dark gray silty clay loam.	Very dark grayish-brown and very dark gray silty clay loam.	Slow to moderate.
Poor	Very dark gray loam to clay loam	Very dark grayish-brown and very dark gray clay loam.	Slow to moderate.
Intermediate	Very dark gray silt loam	Mottled dark grayish-brown silty clay loam to silty clay.	Slow to very slow.
Good	Very dark grayish-brown loamy fine sand; dark grayish-brown subsurface layer.	Brown loam	Rapid.
Good	Very dark grayish-brown, fine sandy loam.	Dark-brown fine sandy loam	Rapid to very rapid.
Good	Very dark grayish-brown loam	Dark-brown fine sandy loam	Rapid.
Good	Very dark grayish-brown sandy loam	Dark-brown sandy loam	Rapid.
Intermediate	Very dark gray silt loam; calcareous	No B horizon	Moderate.

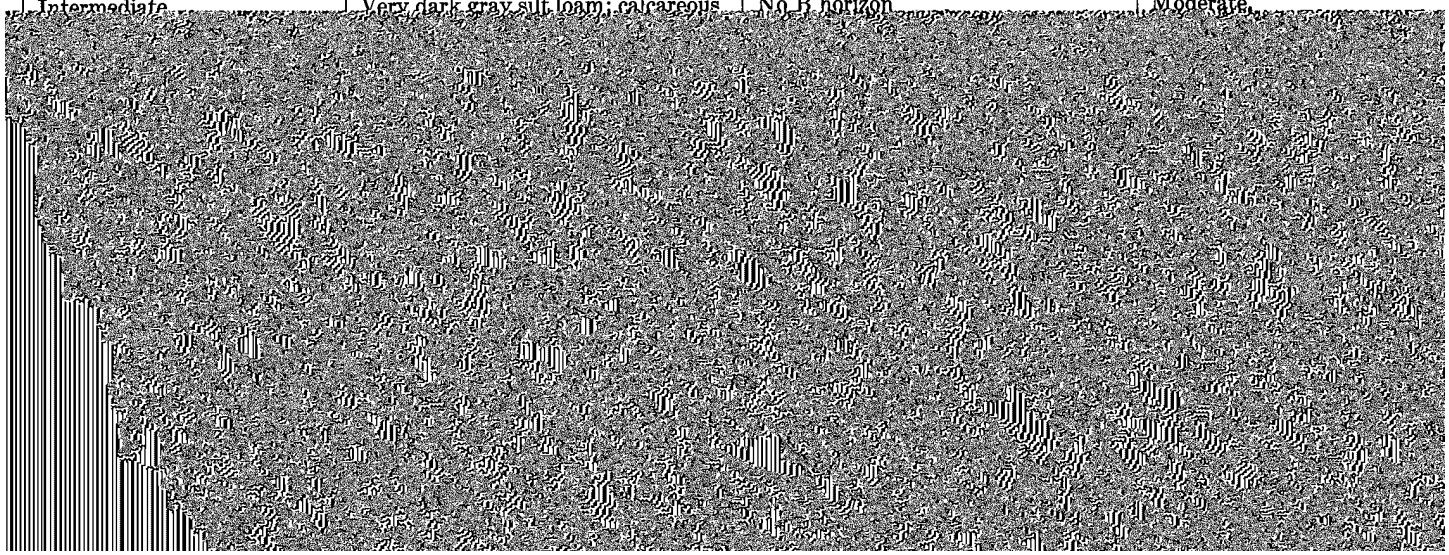


TABLE 3.—*Summary of major*

Soil	Slope range	Parent material, or substratum	Position on landscape	Native vegetation
	Percent			
Harpster loam	0 to 2	Cary glacial loam till	Rims around former ponds, and sloughs in northern four-fifths of county.	Prairie
Hayden loam	0 to 40	Cary glacial loam till	Uplands along streams in northern four-fifths of county.	Forest
Huntsville sandy loam	0 to 2	Recent stream deposits; somewhat sandy.	First bottoms	Shrubs and trees
Huntsville silt loam	0 to 2	Recent stream deposits	First bottoms	Trees, shrubs, or prairie grasses.
Ida silt loam	5 to 9	Windblown silt (loess)	Uplands in northern part of county.	Prairie
Judson silt loam	2 to 9	Local alluvium	Foot slopes and alluvial fans between uplands and bottom lands in southeastern part of county.	Prairie
Kato loam, moderately deep over sand and gravel.	1 to 3	Glacial outwash	Second bottoms or terraces	Prairie
Kato loam, deep over sand and gravel.	1 to 3	Glacial outwash	Second bottoms	Prairie
Ladoga silt loam	2 to 30	Thick, windblown silt (loess)	Uplands near streams in southwestern part of county.	Prairie-forest transition
Lakeville sandy loam	2 to 40	Sandy or gravelly, calcareous Cary glacial till.	Uplands in northern four-fifths of county.	Prairie
Lamont fine sandy loam	2 to 30	Wind-deposited fine sand and silt.	Uplands, mostly on east side of Des Moines River.	Forest
Lester loam	0 to 40	Cary glacial loam till	Uplands adjacent to Des Moines and Skunk Rivers in northern four-fifths of county.	Prairie-forest transition
LeSueur loam	1 to 3	Cary glacial loam till	Uplands near Skunk and Des Moines Rivers in northern four-fifths of county.	Prairie-forest transition
Lindley loam	9 to 40	Kansan glacial till	Uplands in southeastern part of county.	Forest
Marshan silty clay loam, deep over sand and gravel.	0 to 2	Glacial loamy outwash over sand and gravel.	Second bottoms, or terraces	Prairie
Marshan silty clay loam, moderately deep over sand and gravel.	0 to 2	Glacial loamy outwash over sand and gravel.	Outwash terraces along Skunk and Des Moines Rivers.	Prairie
Muck, moderately shallow	0 to 1	Plant residues over moderately fine textured material.	Depressions in northern four-fifths of county.	Prairie
Muck, very shallow	0 to 1	Plant residues over moderately fine textured mineral material.	Depressions in northern four-fifths of county.	Prairie
Muscatine silt loam	1 to 3	Thick, windblown silt (loess)	Upland ridgetops in southeastern part of county.	Prairie
Nicollet loam	1 to 3	Cary glacial loam till	Uplands in northern four-fifths of county.	Prairie
Nodaway silt loam	0 to 2	Recent loamy stream deposits	First bottoms n southern part of county.	Shrubs and trees
Okoboji silt loam	0 to 1	Local alluvium	Uplands in depressions in northern four-fifths of county.	Prairie
Olmitz loam	2 to 9	Local alluvium	Base of slopes and fans between uplands and bottom lands in southeastern part of county.	Prairie
Olmitz sandy loam	0 to 5	Sandy local alluvium	Base of slopes and fans between uplands and bottom lands in southern part of county.	Prairie
Peat	0 to 1	Raw organic matter accumulations and mineral soil.	Depressions in northern four-fifths of county.	Prairie
Riverwash	(3)	Fresh stream deposits; mixed sand and loam.	Low first bottoms	Shrubs and willows
Rolfe loam	0 to 1	Slopewash or Cary glacial loam till; some glacial outwash.	Shallow depressions and glacial terraces along Des Moines River.	Prairie
Runnells silt loam	5 to 40	Windblown silt (loess) over shale.	Uplands in southeastern part of county.	Prairie-forest transition
Sarpy loamy sand	0 to 2	Freshly deposited, coarse, sandy	Low first bottoms of Des Moines	Trees, shrubs, and grass

characteristics of soil types—Continued

Dominant natural drainage [1]	Surface layer (A horizon, uneroded)	Subsoil (B horizon, if present)	Permeability of subsoil [2]
Poor	Dark-gray loam	Olive-gray and grayish-brown loam to clay loam.	Moderate.
Good	Very dark grayish-brown loam; brown subsurface layer.	Yellowish-brown clay loam	Moderate.
Intermediate	Very dark grayish-brown sandy loam	No B horizon	Rapid.
Intermediate	Very dark gray silt loam	Mottled very dark grayish-brown silt loam or loam.	Moderate.
Good	Dark grayish-brown silt loam	No B horizon	Moderate.
Good to intermediate	Very dark brown to very dark grayish-brown silt loam.	Dark grayish-brown and dark-brown silt loam.	Moderate.
Intermediate	Very dark gray loam	Dark grayish-brown loam	Moderate to rapid.
Intermediate	Very dark gray loam	Mottled very dark grayish-brown silt loam or loam.	Moderate.
Good	Very dark grayish-brown silt loam; grayish-brown subsurface layer.	Yellowish-brown silty clay loam	Moderate.
Good	Very dark grayish-brown sandy loam	Brown and yellowish-brown sandy loam.	Rapid.
Good	Very dark brown or very dark grayish-brown fine sandy loam; grayish-brown subsurface layer.	Yellowish-brown fine sandy loam or loam.	Rapid.
Good	Very dark grayish-brown loam	Dark-brown and dark yellowish-brown loam and clay loam.	Moderate.
Intermediate	Very dark gray loam; dark-gray and very dark grayish-brown subsurface layer.	Mottled dark grayish-brown clay loam.	Slow to moderate.
Good	Dark grayish-brown loam	Yellowish-brown or reddish clay loam or gritty silty clay.	Slow to moderate.
Poor	Black silty clay loam	Very dark grayish-brown and olive-gray silty clay loam or clay loam.	Moderate to rapid.
Poor	Black silty clay loam	Very dark grayish-brown and olive-gray clay loam or loam.	Rapid.
Very poor	Black muck	Dark olive-gray silty clay loam	Moderate.
Very poor	Black muck	Dark olive-gray silty clay loam	Moderate.
Intermediate	Very dark brown silt loam	Very dark grayish-brown silty clay loam.	Moderate.
Intermediate	Very dark brown loam to silt loam	Mottled very dark grayish-brown loam to clay loam.	Moderate.
Good to intermediate	Dark grayish-brown silt loam	No B horizon	Moderate.
Very poor	Black silt loam to mucky silt loam	Mottled grayish-brown and olive-brown silt loam.	Moderate.
Intermediate	Very dark brown loam	Dark grayish-brown loam	Moderate.
Intermediate	Dark grayish-brown sandy loam	Grayish-brown sandy loam	Rapid.

TABLE 3.—*Summary of major*

Soil	Slope range	Parent material, or substratum	Position on landscape	Native vegetation
	Percent			
Shelby loam	5 to 30	Kansan glacial till	Uplands in southern part of county.	Prairie
Storden loam	3 to 40	Cary glacial till	Uplands in northern four-fifths of county.	Prairie
Stronghurst silt loam	0 to 2	Thick, windblown silt (loess)	Upland ridgetops and terraces in southeastern part of county.	Forest
Tama silt loam	0 to 14	Thick, windblown silt (loess)	Uplands in southeastern part of county.	Prairie
Terril loam	0 to 9	Slopewash from Clarion or Storden soils.	Foot slopes and fans along Skunk and Des Moines Rivers.	Prairie
Wabash silty clay	0 to 1	Slack-water clayey alluvium	Bottom lands	Prairie and trees
Wabash silt loam	0 to 1	Slack-water clayey alluvium	Bottom lands	Prairie and trees
Waukegan loam, moderately deep over sand and gravel.	0 to 9	Loamy Cary glacial outwash over sand and gravel.	Stream terraces along Skunk, Des Moines, and Raccoon Rivers.	Prairie
Waukegan loam, deep over sand and gravel.	0 to 9	Loamy glacial outwash over sand and gravel.	Stream terraces along Skunk, Des Moines, and Raccoon Rivers.	Prairie
Webster silty clay loam	0 to 1	Cary loam till and loam outwash.	Level uplands in northern four-fifths of county.	Prairie

[1] Good = well drained, moderately well drained, somewhat excessively drained, and excessively drained; intermediate = imperfectly drained; poor = poorly drained and very poorly drained.

[2] Permeability is here defined as the estimated rate at which water can move or flow through the subsoil layer. Sloping soils that have very slow permeability are highly susceptible to erosion and cannot be tiled if wet; soils that have slow permeability may or may not be drainable with tile depending on local conditions. In this table, "very slow" and "slow" indicate that less than 1 inch of water can flow through per hour; "medium," that the rate of flow is 1 to 10 inches per hour; "rapid" and "very rapid," that the rate is more than 10 inches per hour.

[3] Variable.

characteristics of soil types—Continued

Dominant natural drainage [1]	Surface layer (A horizon, uneroded)	Subsoil (B horizon, if present)	Permeability of subsoil [2]
Good	Very dark grayish-brown loam	Brown loam to clay loam	Moderate to slow.
Good	Very dark grayish-brown loam	No B horizon	Moderate.
Intermediate	Dark grayish-brown silt loam; dark-gray subsurface layer.	Mottled brown and dark grayish-brown silty clay loam.	Slow.
Good	Very dark brown silt loam	Dark-brown silty clay loam	Moderate.
Good	Very dark brown loam	Very dark grayish-brown and dark-brown loam.	Moderate.
Poor	Black silty clay to silty clay loam	Dark-gray silty clay	Very slow.
Poor	Black silt loam	Dark-gray silty clay	Very slow.
Good	Very dark brown loam	Brown loam	Rapid.
Good	Very dark brown loam to silt loam	Dark-brown to yellowish-brown loam to silty clay loam.	Moderate to rapid.
Poor	Black silty clay loam	Olive-gray and dark grayish-brown silty clay loam and clay loam.	Slow to moderate.

characteristics of the soils and the potential productivity of the soils should be known. Some of the characteristics to be considered in soil management are discussed in the following paragraphs.

Drainage and permeability.—Drainage and permeability are defined in the section, Soil Survey Methods and Definitions.

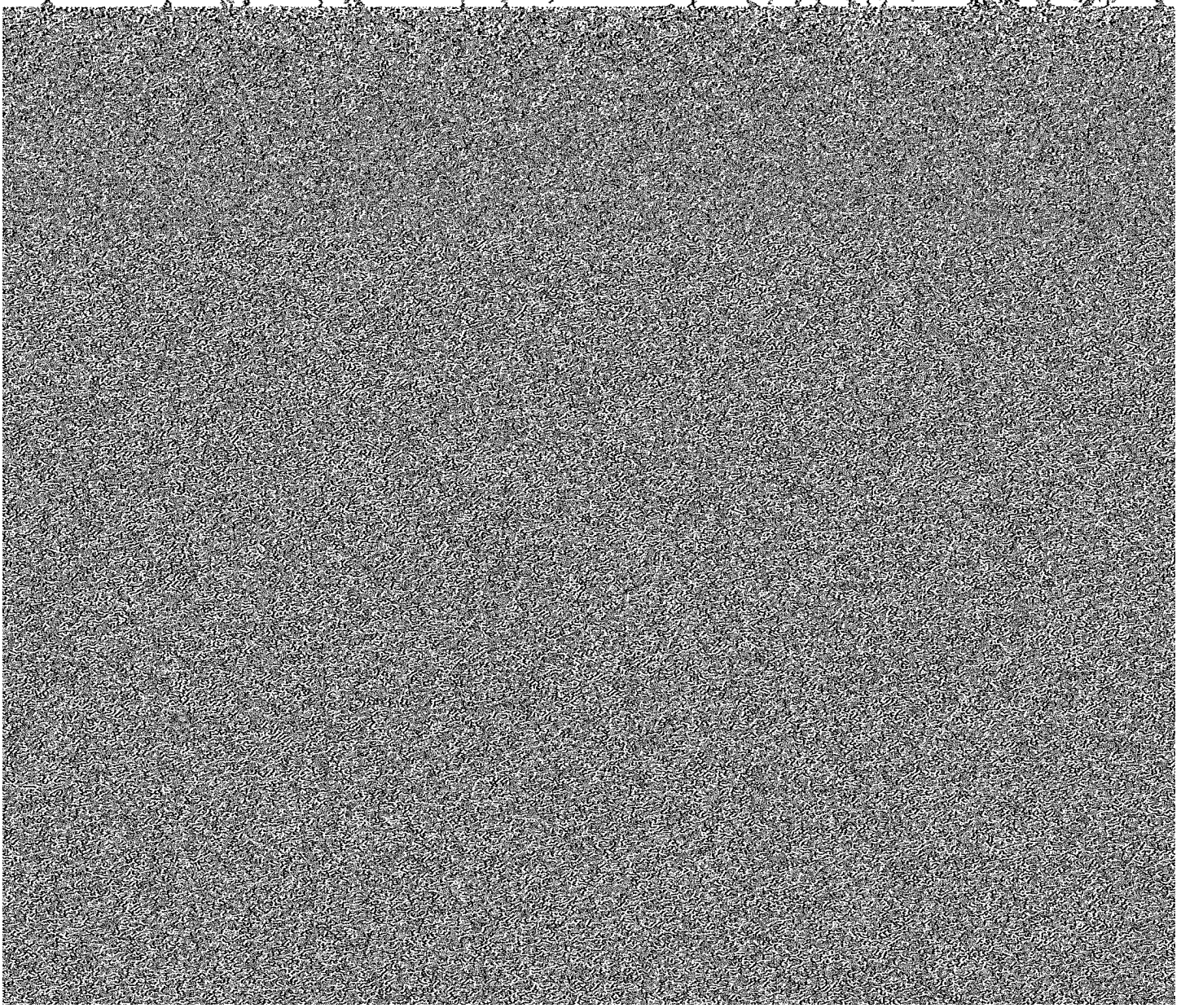
Drainage affects crop yields. Wet soils do not produce high yields of corn, soybeans, alfalfa, and small grains. Corn and alfalfa need a deep root zone for best growth. If the soils are wet, plants do not root deeply, nutrients are not readily available, weeds are difficult to control, and planting and cultivation are often delayed.

Poorly drained soils need to be artificially drained. Tile drains work well in soils that are moderately permeable or moderately to slowly permeable. They do not work well in very slowly permeable soils, which

ent rotation may be necessary than on level soils where erosion is not a problem.

Moreover, the crop rotation selected should depend on accompanying practices. For example, if no nitrogen fertilizer or manure is used, it is very important that a good legume is included in the rotation to supply the nitrogen needed for grain. If terraces and contour cultivation are used as erosion control practices, meadow need not be used so long in the rotation.

Suggested rotations or uses and erosion control practices for all soils can be found in the section, Descriptions of Soils, and in table 4. High yields of suitable row crops can be obtained from productive soils if the suggested rotations and special practices are used. The rotation of crops and accompanying practices will reduce erosion losses to a reasonable minimum and maintain a satisfactory level of organic matter, provided the soils are fertilized according to



stalks, or other crop residues on the surface or partially buried, helps to control wind erosion. It is particularly needed on sandy soils.

The Soil Conservation Service, assisting the Polk County Soil Conservation District, can help make an erosion control plan for your farm. Useful sugges-

tices, improved farming practices, or new information may make it necessary to revise the estimates of average yields in the future.

Capability Groups of Soils

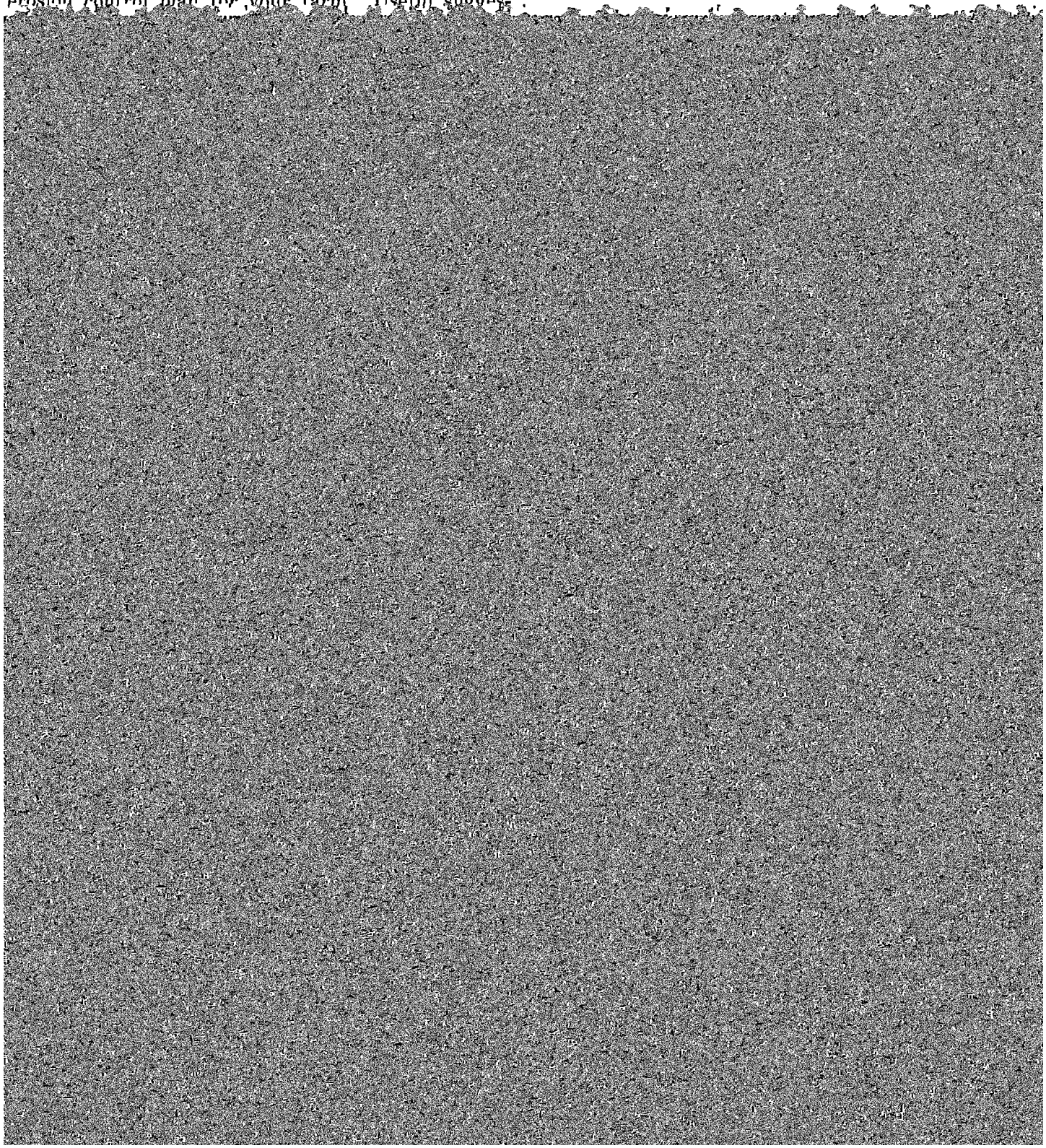
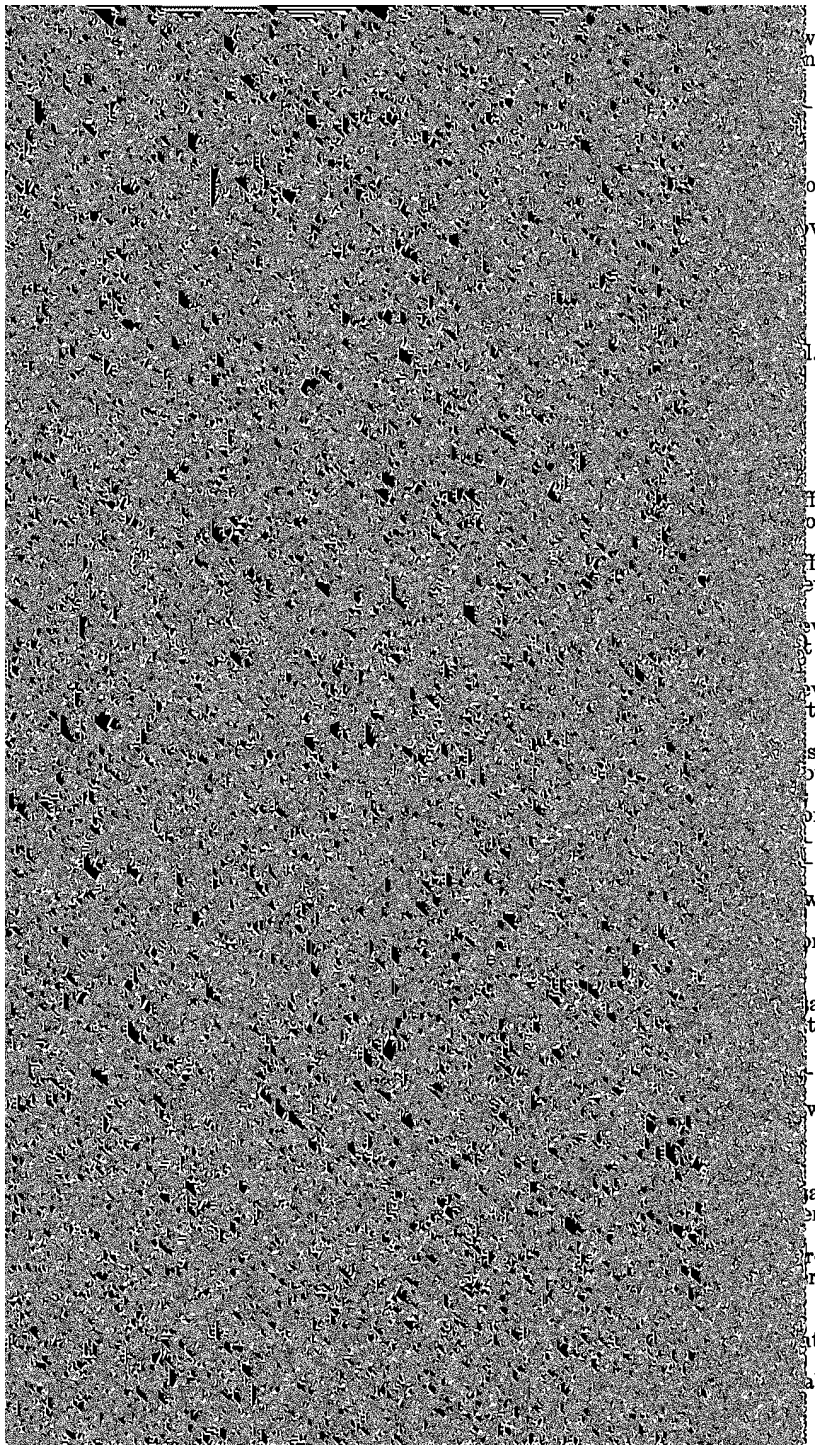


TABLE 4.—*Expected average yields, suggested rotations, and principal management problems*

[See text preceding for assumptions on which estimates of yields are based]

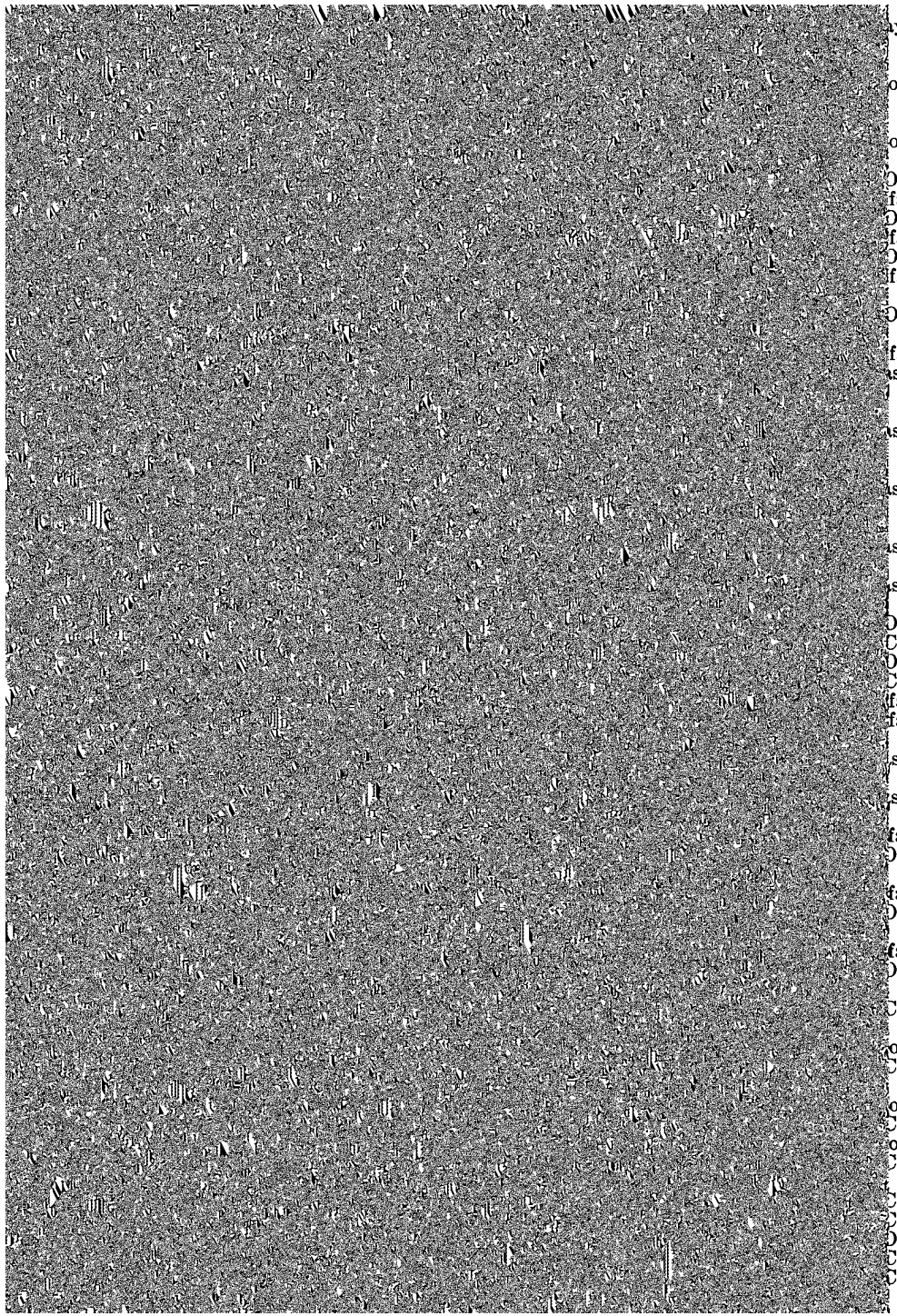
Map symbol	Soil	Capability Subclass	Most serious limiting factors	Suggested rotations or other land use [1]	Special management needs	Expected average acre yields of crops in the suggested rotation, under a high level of management [2]			
						Corn	Soybeans	Oats	Hay
						Bu.	*Bu.*	*Bu.*	*Tons*
AaC	Adair clay loam, 5 to 9 percent slopes.	IIIw	Moderate erosion hazard; slight wetness; "tight" subsoil.	Same as surrounding soils.	If cultivated, interceptor tile drainage and terraces.	26	------	20	1.0
AaC2	Adair clay loam, 5 to 9 percent slopes, moderately eroded.	IIIw	Moderate erosion hazard; slight wetness.	Same as surrounding soils.	Same	25	------	20	1.0
AaD2	Adair clay loam, 9 to 14 percent slopes, moderately eroded.	IVe	Severe erosion hazard; slight wetness.	Hay or pasture	None	------	------	------	------
AbC3	Adair soils, 5 to 9 percent slopes, severely eroded.	IVe	Moderate erosion hazard; little or no topsoil.	Hay or pasture	None	------	------	------	------
AbD3	Adair soils, 9 to 14 percent slopes, severely eroded.	IVe	Severe erosion hazard; thin or no topsoil; slight wetness.	Hay or pasture	None	------	------	------	------
Ac	Alluvial land	IIw	Very severe flood and wetness hazards; channeling.	CS	Surface drainage; levees.	60	25	------	------
Ad	Ames loam	IIIw	Poor drainage; "tight" subsoil	CSOM	Shallow surface ditches	50	19	35	2.0
				Hay or pasture	None	------	------	------	------
AeA	Ankeny sandy loam, 0 to 2 percent slopes.	IIs	Droughtiness; sand overwash; difficult fertility maintenance.	COM	Mulch tillage	48	18	36	1.8
				Alfalfa	None	------	------	------	------
AeB	Ankeny sandy loam, 2 to 5 percent slopes.	IIs	Droughtiness; slight erosion hazard; difficult fertility maintenance.	COM	Mulch tillage	44	16	32	1.6
				Alfalfa	None	------	------	------	------
AfA	Atterberry silt loam, 1 to 3 percent slopes.	I	Slight wetness	CCOM	Possibly tile drainage	73	27	50	3.0
AgA	Atterberry silt loam, bench position, 1 to 3 percent slopes.	I	Runoff from slopes above; slight wetness.	CCOM	Possibly tile drainage and diversion terraces.	73	27	50	3.0
BaC2	Bauer silt loam, 5 to 9 percent slopes, moderately eroded.	IVe	Moderate erosion hazard; shallowness; low natural fertility.	COMMMM	Contouring	20	12	20	.8
				Hay or pasture	None	------	------	------	------
BaD2	Bauer silt loam, 9 to 14 percent slopes, moderately eroded.	VIe	Severe erosion hazard, some gullying; shallowness; low fertility.	Woodland or pasture	None	------	------	------	------
BaE2	Bauer silt loam, 14 to 20 percent slopes, moderately eroded.	VIIe	Severe erosion; shallowness; low fertility.	Woodland or pasture	None	------	------	------	------
BaF2	Bauer silt loam, 20 to 40 percent slopes, moderately eroded.	VIIe	Very severe erosion hazard; shallowness; low fertility.	Woodland or pasture	None	------	------	------	------
BbA	Blockton silt loam, 0 to 2 percent slopes.	IIw	Poor drainage; runoff from slopes above; poor workability; flood hazard in some areas.	CSCOM	Diversion terraces and surface drainage.	58	24	35	1.8
				CSOgm	Same	52	22	33	------
BbB	Blockton silt loam, 2 to 5 percent slopes.	IIw	Poor drainage; poor workability; slight erosion hazard.	CSCOM	Surface drainage	60	26	36	2.0
				CSOgm	Surface drainage	54	24	34	------
BcA	Buckner loamy sand, 0 to 2 percent slopes.	IIIs	Extreme droughtiness; hazard of wind erosion; difficult fertility maintenance.	Specialty crops, small grain, or alfalfa.	Mulch tillage	------	------	------	------
BcB	Buckner loamy sand, 2 to 5 percent slopes.	IIIs	Extreme droughtiness; hazard of wind erosion and some hazard of water erosion; difficult fertility maintenance.	Specialty crops or alfalfa.	Mulch tillage	------	------	------	------
BcC	Buckner loamy sand, 5 to 9 percent slopes.	IIIs	Extreme droughtiness; hazard of wind and water erosion; difficult fertility maintenance.	Specialty crops or alfalfa.	Mulch tillage and contouring.	------	------	------	------
BdB	Buckner-Hagener complex, 2 to 5 percent slopes.	IIIs	Droughtiness; slight wind and water erosion hazards; difficult fertility maintenance.	COM	Mulch tillage and contouring.	36	15	25	1.6
				Alfalfa		------	------	------	------



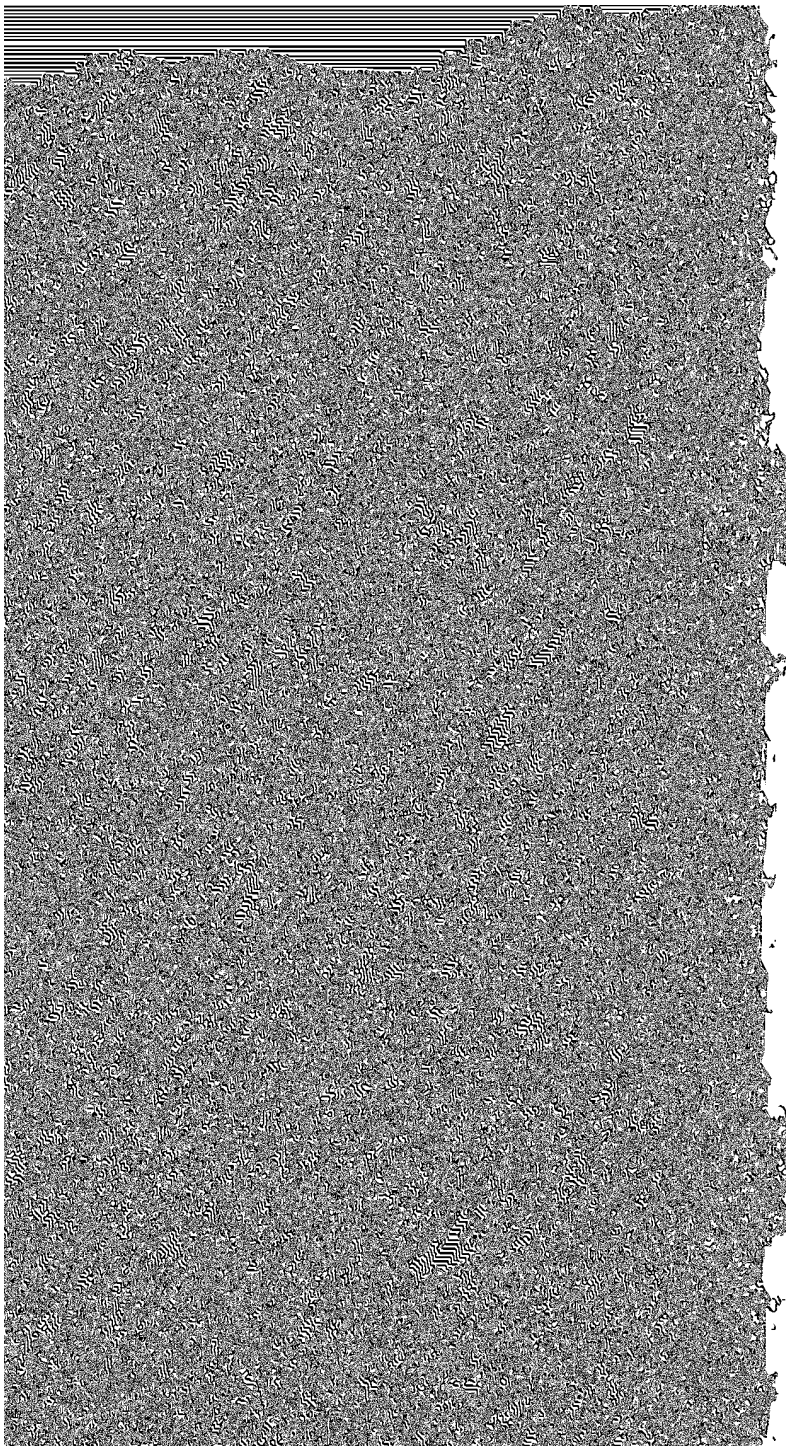
vind and n hazards;	COM	Mulch tillage and contouring.	32	------	22	1.5
	Alfalfa					
	Same as surrounding soils.	Possibly diversion terraces and surface drainage if cultivated.	55	24	46	3.0
osion haz-	Same as surrounding soils.	Same	55	24	46	3.0
ve; slight	Same as surrounding soils.	Possibly diversion terraces for overflow protection and tile drainage if cultivated.	65	27	48	3.2
wetness; l.	Same as surrounding soils.	Possibly diversion terraces for overflow protection and tile drainage if cultivated; grassed waterways to control runoff and prevent gullying.	65	27	48	3.2
fficult fer- osion haz-	Small grains or alfalfa	Mulch tillage	------	------	------	------
fficult fer- evere ero-	Woodland or pasture	None	------	------	------	------
evere ero- t fertility	Woodland or pasture	None	------	------	------	------
evere ero- tural fer-	Woodland or pasture	None	------	------	------	------
soil; low on.	Same as surrounding soils.	Interceptor tile and terraces if cultivated.	20	------	15	.8
soil; low on hazard.	Hay or pasture	None	------	------	------	------
	CSCOM	None	77	29	52	3.2
	CCOMM	None	75	29	52	3.0
	CSCOM	Contouring	75	29	52	3.0
w organic-	CCOMM	None	72	28	50	3.0
	CSCOM	Contouring	72	28	50	3.0
on hazard	COMMM	None	71	26	49	2.9
	CCOMM	Contouring	71	26	49	2.9
	CCOM	Terracing	71	26	49	2.9
ard; low t.	COMMM	None	68	24	47	2.8
	CCOMM	Contouring	68	24	47	2.8
	CCOM	Terracing	68	24	47	2.8
	Hay or pasture	None	60	------	40	2.6
	CCOMM	Terracing	60	------	40	2.6
w organic-	Hay or pasture	None	------	------	------	------
gullying;	Pasture	None	------	------	------	------
ard; low nt; thin	COMMMM	None	62	20	43	2.6
	COMM	Contouring	62	20	43	2.6
	CCOMM	Terracing	62	20	43	2.6
rd; gully- r content;	Hay or pasture	None	------	------	------	------
	COM	Terracing	50	------	38	2.2
gullying; tent; thin	Pasture	None	------	------	------	------
allowness	CCOMM	None	70	26	48	2.8

oblems—Continued

cial ent needs	Expected average acre yields of crops in the suggested rotation, under a high level of management [2]			
	Corn	Soybeans	Oats	Hay
	Bu.	*Bu.*	*Bu.*	*Tons*
----------	66	25	46	2.7
----------	60	23	42	2.6
----------	60	23	42	2.6
----------	78	30	53	3.4
----------	78	30	53	3.4
----------	73	26	49	3.2
----------	73	26	49	3.2
----------	73	26	49	3.2
----------	62	------	45	2.8
----------	62	------	45	2.8
----------	------	------	------	------
e and con- cultivated.	60	23	40	2.2
----------	55	22	38	2.2
----------	------	------	------	------
ace drain- ection from	70	29	52	3.0
----------	64	27	50	------
ace drain- ection from	62	26	42	2.4
----------	56	24	38	------
e drainage, n from or both, ted.	65	27	34	2.6
ace drain- protection rflow if d.	72	29	52	3.0
----------	74	30	53	3.2
inage and n from	65	28	50	2.6
----------	60	26	48	------
ge----------	39	15	30	1.8
----------	------	------	------	------
and mulch	33	14	27	1.8
----------	------	------	------	------

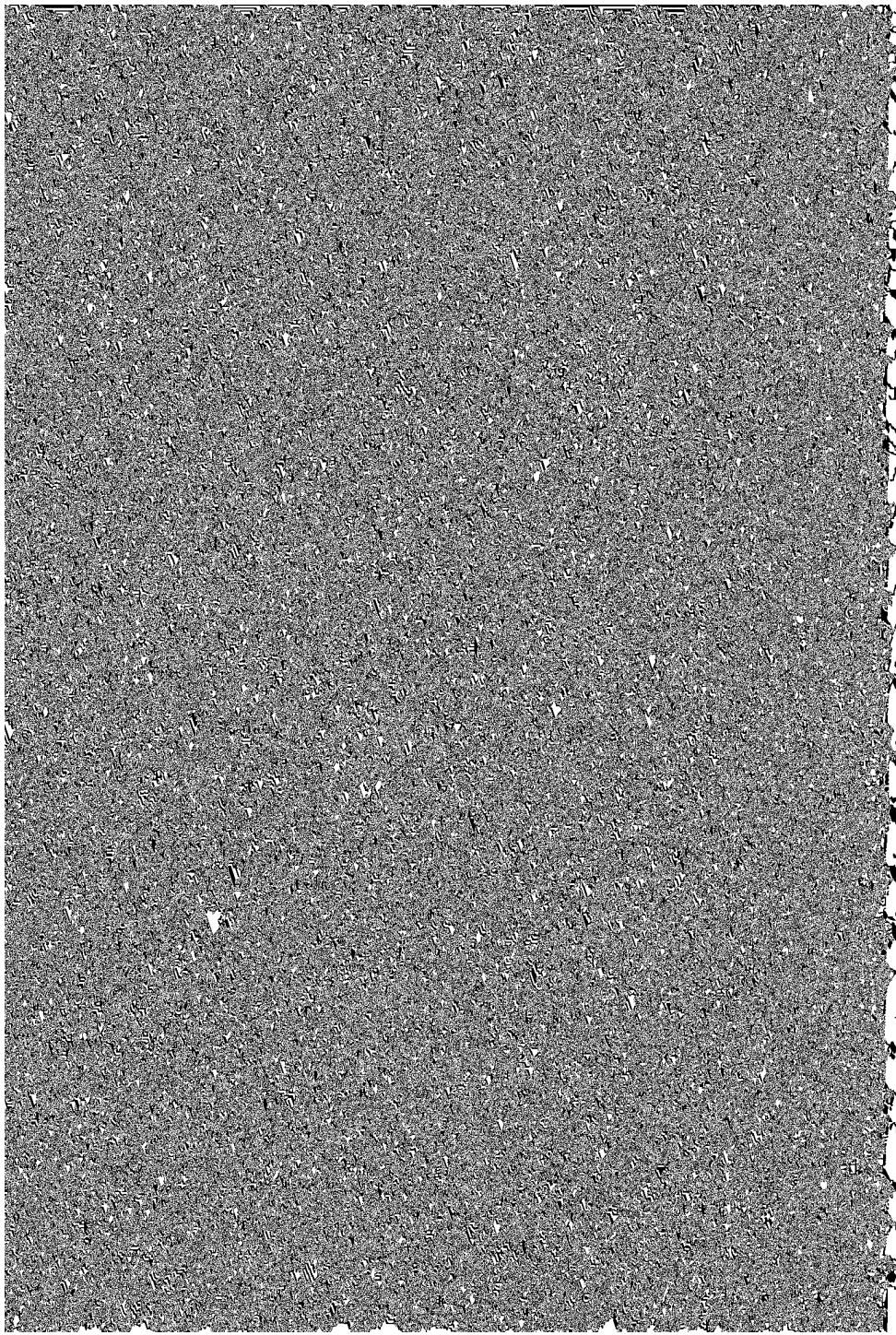


y or pasture	None				
oodland or pasture	None				
oodland or pasture	None				
OM	Mulch tillage	44	18	36	2.0
falfa	None				
OM	Mulch tillage	43	17	36	2.0
falfa	None				
OM	Mulch tillage	40	15	34	1.7
falfa	None				
OMMM	Contouring and mulch tillage.	35		32	1.6
falfa	None				
sture	None				
sture	None				
sture	None				
sture	None				
sture	None				
OM	None	45	18	38	2.2
COM	Contouring	45	18	38	2.3
OMMM	Contouring	40	15	34	2.0
COM	Terracing				
falfa	None				
falfa	None				
sture	None				
sture	None				
falfa	None				
OM	None	42	18	30	1.7
falfa	None				
OM	Mulch tillage and contouring.	40	18	30	1.7
falfa					
OMM	Mulch tillage and contouring.	35	16	28	1.5
COgm	Protection from overflow.	60	24	50	
oodland or pasture	None				
COgm	Protection from overflow.	35	18	35	
oodland or pasture	None				
COgm	Overflow protection	55	25	45	
oodland or pasture	None				
COM	None	80	29	50	3.2
COMM	None	78	29	50	3.2
COM	Contouring	78	29	50	3.2
OMMM	None	70	27	46	3.0
COMM	Contouring	70	27	46	3.0
COM	Terracing	70	27	46	3.0



...tions, and principal management problems—Continued

...s	Suggested rotations or other land use [1]	Special management needs	Expected average acre yields of crops in the suggested rotation, under a high level of management [2]			
			Corn	Soybeans	Oats	Hay
			Bu.	*Bu.*	*Bu.*	*Tons*
-----	CCOMM	Terracing	62	------	42	2.8
	Hay or pasture	None	------	------	------	------
-----	Hay, pasture, or woodland.	None	------	------	------	------
-----	Pasture or woodland	None	------	------	------	------
...thin	COMM	Contouring	64	24	42	2.8
	CCOMM	Terracing	64	24	42	2.8
...thin	COMM	Terracing or strip-cropping.	58	------	38	2.6
	Hay, pasture, or woodland.	None	------	------	------	------
...sur-	Pasture or woodland	None	------	------	------	------
...naz-	COM	Mulch tillage	53	18	36	2.2
	CCOM	Mulch tillage and contouring.	53	18	36	2.2
----	COMMM	Mulch tillage	48	16	34	2.0
	COMM	Mulch tillage and contouring.	48	16	34	2.0
	CCOM	Mulch tillage and terracing.	48	16	34	2.0
...ium	COMMM	Mulch tillage	46	16	28	2.0
	COMM	Mulch tillage and contouring.	46	16	28	2.0
	CCOM	Mulch tillage and terracing.	46	16	28	2.0
----	Hay or pasture	None	------	------	------	------
...ero-	Pasture	None	------	------	------	------
----	Pasture	None	------	------	------	------
...nat-	CCOM	None	74	28	48	3.0
...defi-	CCOMM	None	74	28	48	3.0
	CCOM	Contouring	74	28	48	3.0
...defi-	CCOMM	None	73	27	46	3.0
	CCOM	Contouring	73	27	46	3.0
de-	COMM	Contouring	68	26	44	2.8
	CCOM	Terracing	68	26	44	2.8
----	CCOMM	Terracing	58	------	40	2.6
----	Hay or pasture	None	------	------	------	------
----	Hay or pasture	None	------	------	------	------
----	Pasture or woodland	None	------	------	------	------
----	Pasture or woodland	None	------	------	------	------



OMM	None	74	28	48	3.0
OM	Contouring	74	28	48	3.0
MMM	Contouring	61	23	40	2.6
MMM	Terracing	61	23	40	2.6
MM	Terracing or strip-cropping.	55	------	36	2.4
or pasture	None	------	------	------	------
ure or woodland	None	------	------	------	------
MM	Contouring	40	------	32	2.0
OMM	Terracing	40	------	32	2.0
M	Terracing	38	------	30	1.8
or pasture	None	38	------	30	1.8
, pasture, or woodland.	None	------	------	------	------
, pasture, or woodland.	None	------	------	------	------
dland or pasture	None	------	------	------	------
dland or pasture	None	------	------	------	------
e as surrounding ils.	Tile and surface drainage.	(3)	(3)	(3)	(3)
dland or pasture	None	------	------	------	------
dland or pasture	None	------	------	------	------
dland or pasture	None	------	------	------	------
dland or pasture	None	------	------	------	------
dland or pasture	None	------	------	------	------
e as surrounding ils.	Tile drainage and diversion terraces for protection from overflow if cultivated.	65	29	50	3.0
M	Mulch tillage	38	15	26	1.6
fa	None	------	------	------	------
M	Mulch tillage	38	15	25	1.6
fa	None	------	------	------	------
M	Mulch tillage	38	15	25	1.6
fa	None	------	------	------	------
M	Mulch tillage	36	14	24	1.6
fa	None	------	------	------	------
M	Mulch tillage and contouring	34	------	22	1.5
fa	None	------	------	------	------
M	Mulch tillage and contouring	30	------	20	1.4
fa	None	------	------	------	------
ure	None	------	------	------	------
ure	None	------	------	------	------
ure	None	------	------	------	------
e as surrounding ls.	Tile drainage; potash fertilizers.	60	24	40	2.5

…lems—Continued

…needs	Expected average acre yields of crops in the suggested rotation, under a high level of management [2]			
	Corn	Soy-beans	Oats	Hay
	Bu.	*Bu.*	*Bu.*	*Tons*
…ge	65	24	46	2.8
…	65	24	45	2.8
…	65	24	45	2.8
…	62	22	44	2.7
…	62	22	44	2.7
…	58	------	40	2.6
…	58	------	40	2.6
…	58	------	40	2.6
…	51	------	36	2.4
…	51	------	36	2.4
…	51	------	36	2.4
…	------	------	------	------
…	------	------	------	------
…	------	------	------	------
…ction	65	27	48	------
…ction	45	20	38	------
…	55	------	34	2.4
…	55	------	34	2.4
…drainage …erraces, …protec- …erflow	75	29	50	3.2
…	70	27	47	3.0
…	54	23	40	2.0
…rainage	69	28	50	------
…rainage	76	30	55	3.0
…	70	26	45	3.0
…	70	26	45	3.0
…	64	22	40	2.8
…	64	22	40	2.8
…	55	------	36	2.4
…	55	------	36	2.4
…	55	------	36	2.4
…	------	------	------	------
…	------	------	------	------
…	52	17	34	2.4
…	52	17	34	2.4

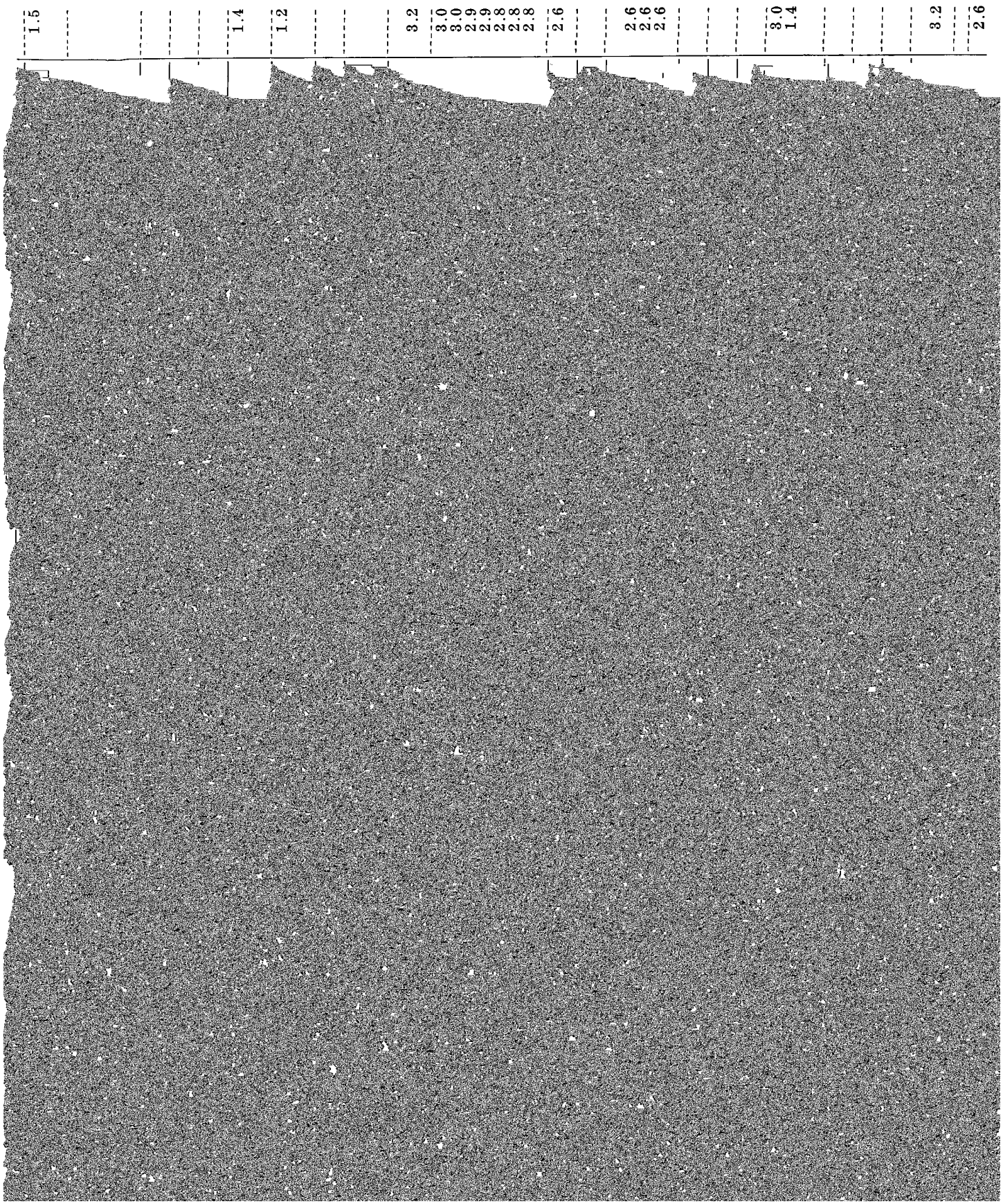

1.5
1.4
1.2
3.2
3.0
3.0
2.9
2.8
2.8
2.8
2.6
2.6
2.6
2.6
3.0
1.4
3.2
2.6

TABLE 4.—*Expected average yields, suggested rotations, and principal management problems—Continued*

Map symbol	Soil	Capability subclass	Most serious limiting factors	Suggested rotations or other land use [1]	Special management needs	Expected average acre yields of crops in the suggested rotation, under a high level of management [2]			
						Corn	Soybeans	Oats	Hay
						Bu.	*Bu.*	*Bu.*	*Tons*
Md	Muck, moderately shallow	IIIw	Wetness; lack of outlets for tile drainage; early frost hazard.	Continuous corn or truck crops.	Tile and surface drainage.	(3)	(3)	(3)	(3)
				Pasture	Surface drainage	(3)	(3)	(3)	(3)
Mc	Muck, very shallow	IIIw	Wetness; early frost hazard	Continuous corn or truck crops.	Tile and surface drainage.	(3)	(3)	(3)	(3)
MeA	Muscatine silt loam, 1 to 3 percent slopes.	I	None	CCOM	Possibly tile drainage	85	30	55	3.6
				CCOgm	Possibly tile drainage	78	28	50	------
NaA	Nicollet loam, 1 to 3 percent slopes	I	Slight wetness	CCOM	Possibly tile drainage	81	31	55	3.4
				CCOgm	Possibly tile drainage	73	29	50	------
Nb	Nodaway silt loam	I	Slight wetness; medium flood hazard.	CCOgm	Protection from overflow.	68	28	50	------
Oa	Okoboji silt loam	IIIw	Wetness; lack of outlets for tile drainage in potholes.	Same as surrounding soils.	Tile and surface drainage if cultivated.	(3)	(3)	(3)	(3)
ObB	Olmitz loam, 2 to 5 percent slopes	IIe	Slight wetness	Same as surrounding soils.	May need tile drainage and diversion terraces for protection from overflow if cultivated; grassed waterways.	73	28	50	3.2
ObC	Olmitz loam, 5 to 9 percent slopes	IIIe	Very slight wetness	Same as surrounding soils.	Same	68	27	47	3.0
OcA	Olmitz sandy loam, 0 to 2 percent slopes.	IIs	Droughtiness; slight wetness; low natural fertility.	Same as surrounding soils.	Same	55	20	40	2.0
OcB	Olmitz sandy loam, 2 to 5 percent slopes.	IIs	Droughtiness; slight wetness	Same as surrounding soils.	Same	53	18	38	2.0
Pa	Peat	IIIw	Wetness; shallowness over clayey material.	Continuous corn or truck crops.	Tile and surface drainage.	(3)	(3)	(3)	(3)
				Pasture	Surface drainage	(3)	(3)	(3)	(3)
Ra	Riverwash	VIIs	Extreme droughtiness; very severe flood hazard.	Nonagricultural land	None	------	------	------	------
Rb	Rolfe loam	IIIw	Wetness; very "tight" subsoil	Same as surrounding soils.	Tile with surface intakes and surface drainage.	(3)	(3)	(3)	(3)
Rc	Rolfe loam, bench position	IIIw	Wetness; slight flood hazard; very "tight" subsoil.	Same as surrounding soils.	Same	(3)	(3)	(3)	(3)
RdC2	Runnells silt loam, 5 to 9 percent slopes, moderately eroded.	IIIe	Moderate erosion hazard	Hay or pasture	None	------	------	------	------
				COMM	Contouring	50	------	40	2.4
RdD2	Runnells silt loam, 9 to 14 percent slopes, moderately eroded.	IVe	Severe erosion hazard	Hay or pasture	None	------	------	------	------
RdE2	Runnells silt loam, 14 to 20 percent slopes, moderately eroded.	VIe	Severe erosion hazard; gullying	Pasture or woodland	None	------	------	------	------
RdF2	Runnells silt loam, 20 to 40 percent slopes, moderately eroded.	VIIe	Very severe erosion hazard; gullying.	Pasture or woodland	None	------	------	------	------
ReD3	Runnells soils, 9 to 14 percent slopes, severely eroded.	IVe	Severe erosion hazard; gullying; thin topsoil.	Hay or pasture	None	------	------	------	------
Sa	Sarpy loamy sand	IIIs	Severe flood and drought hazards	Hay or pasture	None	25	------	25	2.0
SbA	Saylor fine sandy loam, 0 to 2 percent slopes.	IIs	Droughtiness; slight wetness in spring; difficult fertility maintenance.	CCOM	Mulch tillage; possibly drainage.	48	22	32	2.0
ScA	Sharpsburg silt loam, 0 to 2 percent slopes.	I	None	CSCOM	Possibly tile drainage	80	30	45	3.2
ScB	Sharpsburg silt loam, 2 to 5 percent slopes.	IIe	Slight erosion hazard	CCOMM	None	76	28	45	3.0
				CSCOM	Contouring	76	28	45	3.0

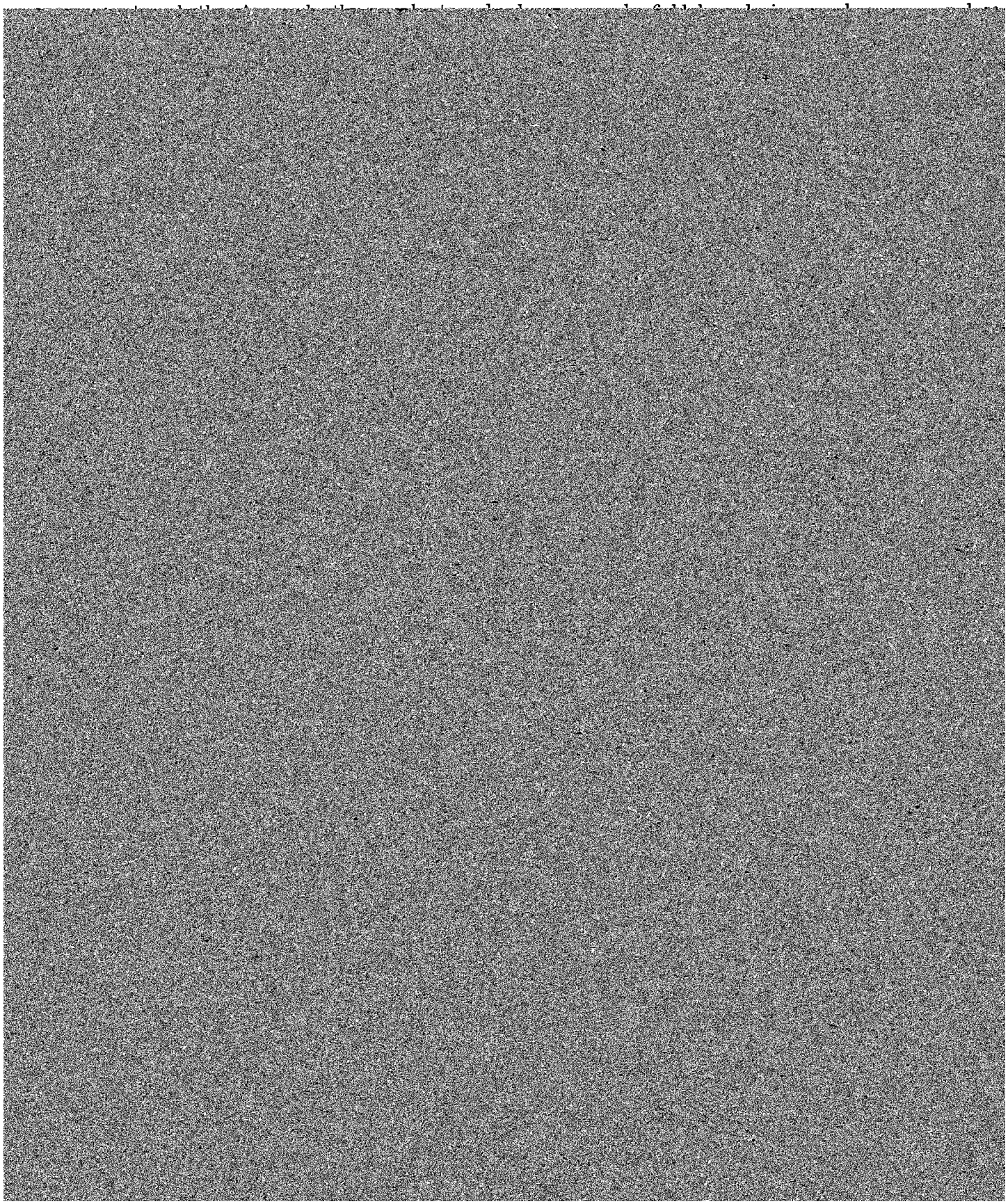
Contouring	69	27	42	2.8
Terracing	69	27	42	2.8
Contouring	66	26	40	2.8
Terracing	66	26	40	2.8
Terracing	60	------	38	2.6
None	------	------	------	------
None	------	------	------	------
Terracing	56	------	32	2.5
None	------	------	------	------
Contouring	50	------	36	2.0
Terracing	50	------	36	2.0
None	------	------	------	------
Terracing	45	------	32	1.8
None	------	------	------	------
None	------	------	------	------
None	------	------	------	------
None	------	------	------	------
Contouring	60	------	39	2.1
Terracing	60	------	39	2.1
None	------	------	------	------
None	------	------	------	------
Contouring	52	------	37	2.0
Terracing	52	------	37	2.0
None	------	------	------	------
Terracing	45	------	35	1.8
None	------	------	------	------
None	------	------	------	------
None	------	------	------	------
Contouring	40	------	34	1.8
Terracing	40	------	34	1.8
None	------	------	------	------
None	------	------	------	------
Possibly tile drainage	65	25	45	2.9
Possibly tile drainage	65	25	45	2.9
None	83	31	55	3.6
None	80	31	55	3.5
Contouring	80	31	55	3.5
None	78	30	53	3.5
Contouring	78	30	53	3.5
Contouring	76	30	52	3.4
Terracing	76	30	52	3.4
Contouring	73	29	50	3.4
Terracing	73	29	50	3.4
Contouring	65	------	46	3.2
Contour stripcropping	65	------	46	3.2
Terracing	65	------	46	3.2
None	------	------	------	------
Terracing	60	------	42	3.0

—Continued

Corn	Soybeans	Oats	Hay
Expected average acre yields of crops in the suggested rotation, under a high level of management [2]			
Bu.	Bu.	Bu	Tons
78	30	55	3.4
77	30	55	3.4
74	28	52	3.2
55	25	40	------
45	22	30	------
60	25	30	2.4
43	18	33	2.0
41	16	31	1.9
41	16	31	1.9
36	------	29	1.7
36	------	29	1.7
68	28	53	2.8
62	26	48	------
65	27	52	2.6
65	27	52	2.6
65	27	52	2.6
58	24	48	2.4
58	24	48	2.4
79	29	55	3.2
71	27	50	------
72	26	50	3.0
64	24	45	------

the crop is not grown or the

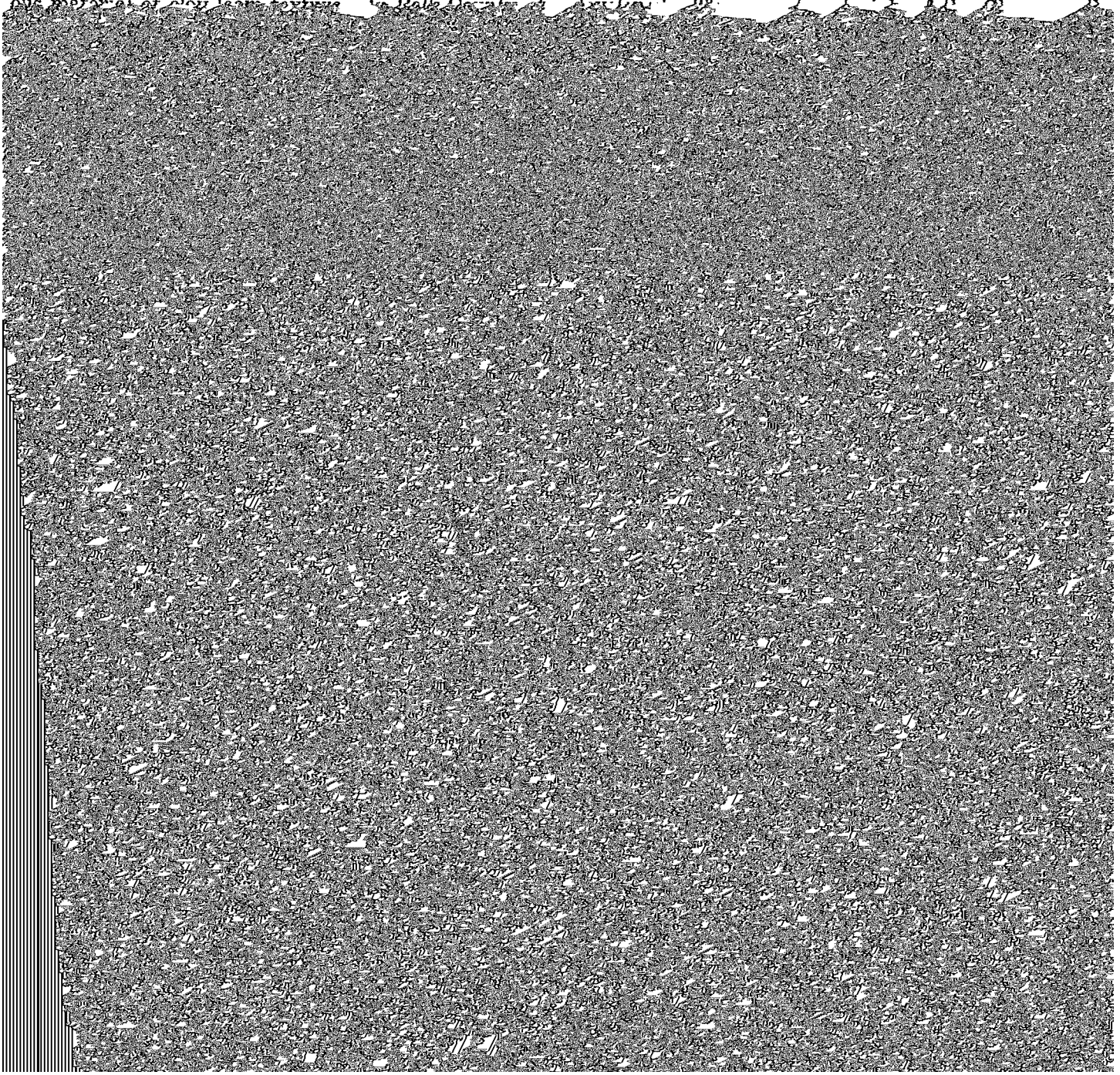
these pothole soils is 50 to
pend on the degree to which
nplete drainage is seldom



to the Des Moines River was the shale exposed so that it weathered and became parent material for soils.

The Bauer and Gosport soils are the only soils in the county that developed entirely from shale. The Runnells soils developed from a thin layer of loess over weathered shale. Many of the soils that developed from the older glacial till are underlain by shale at depths of 4 to 5 feet.

Older glacial till.—Nebraskan and Kansan glacial till are the oldest glacial deposits in the county. The Nebraskan was deposited first and was later covered by the Kansan (7). The Kansan till is firm, calcareous material of clay loam texture. In Polk County it



is also possible that the belt of loess, 1 to 2 miles wide, extending from the Des Moines Airport to the southeastern city limits of Des Moines was deposited during this period. Fayette soils were mapped in this area.

Alluvium and glacial stream terraces.—Water-deposited sediments are extensive along the major streams. Some of these are recent deposits from which the Dorchester, Nodaway, and Sarpy soils have developed. Others, from which the Waukegan soils developed, are sediments deposited during glacial times. Still other water-laid sediments are intermediate in age; from these, the Colo and Huntsville soils have

CLIMATE

Available evidence suggests that in Polk County the soils have been developing under the influence of a midcontinental, subhumid climate for at least 5,000 years. Between 5,000 and 16,000 years ago, the cli-

surface and less acid with increasing depth. The Brunizems in Polk County are the soils of the following series: Adair, Ankeny, Clarion, Clearfield, Cooper, Dickinson, Farrar, Gravity, Hagener, Judson, Kato, Lakeville, Muscatine, Nicollet, Olmitz, Saylor, Sharps-

TABLE 5.—*Laboratory data for selected soils* [1]

Soil type and location of sample	Horizon	Depth	Mechanical analysis: Distribution of particles < 2 mm. in diameter: Sand (> 50 microns)	Coarse silt (50–20 microns)	Fine silt (20–2 microns)	Clay (< 2 microns)	Particles (> 2 mm. in diameter)	pH	Chemical analysis: Free iron	Organic carbon	Bulk density	Exchangeable bases: Ca	Mg	K	Cation exchange capacity
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*		*Percent*	*Percent*		*meq./ 100 gm. of soil*	*meq./ 100 gm. of soil*	*meq./ 100 gm. of soil*	*meq./ 100 gm. of soil*
Ames loam	A_h	0–7	32.3	22.8	23.4	21.5	<1.0	6.9	0.34						
SW¼SE¼SW¼ sec. 12, T. 80 N., R. 24 W., Crocker Township, 30 feet north of State Highway No. 60, 20 feet east of fence on east side of gravel road.	Ae	7–14	28.2	25.2	24.7	21.9	<1.0	6.3	.35						
	B_{11}	14–19	28.4	19.8	24.1	27.7	<1.0	5.3	.44						
	B_{12}	19–23	28.6	16.2	23.1	32.1	<1.0	5.2	.50						
	B_{21}	23–26	29.2	16.2	21.2	33.4	<1.0	4.6	.56						
	B_{22}	26–31	30.8	15.9	17.9	35.4	1.4	5.8	.68						
	B_3	31–37	34.4	16.1	16.6	32.9	1.8	6.3	.60						
	C_1	37–42	40.4	13.0	14.8	31.8	6.6	7.2	.61						
	C_2	42–60	42.3	13.7	16.8	25.1	6.8	7.7	.39						
Clarion loam	A_p	0–9	26.0	20.6	28.4	25.0	<1.0	6.7	.79	1.96	1.17	18.6	5.6	0.28	22.8
SW¼SE¼SW¼ sec. 12, T. 80 N., R. 24 W., Crocker Township, about 1,450 feet east of U. S. 69 on north side of road in fresh road cut—site was formerly in cultivated field.	B_1	9–13	23.0	25.5	24.7	26.8	<1.0	6.0		1.90		13.1	3.9	.26	20.9
	B_{21}	13–17	21.8	26.6	24.4	27.2	<1.0	5.6	.88	1.46	1.06				
	B_{22}	17–22	20.9	26.6	24.7	27.8	<1.0	5.7	.95	1.29	1.15	12.0	3.3	.25	19.4
	B_{23}	22–27	19.8	25.6	27.2	27.4	<1.0	5.8	.78	1.21	1.17	12.1	4.0	.25	19.4
	B_3	27–30	21.4	21.5	32.3	24.8	<1.0	6.2		1.06					
	C_1	30–36	20.8	21.6	31.4	26.2	<1.0	6.5	.72	.64	1.23	13.2	3.8	.24	19.9
	C_2	36–54	39.3	11.2	25.0	24.5	6.5	7.6	.52						
Kato loam, deep over sand and gravel [2]	A_h	0–16	31.7	27.4	19.1	21.8	0	5.9		2.77					
NE¼SW¼SW¼ sec. 34, T. 81 N., R. 25 W., Union Township.	B_1	16–22	25.7	30.2	20.0	24.1	0	5.7		2.07					
	B_2	22–36	24.5	30.7	21.0	23.8	0	5.8		1.09					
	C_{11}	36–48	35.7	28.2	16.6	19.5	0	5.9		.48					
	C_{12}	48–60	39.0	26.4	16.3	18.3	0	6.0		.37					
Marshan silty clay loam, deep over sand and gravel	A_h	0–13	12.0	16.7	36.7	34.6	<1.0	6.2	.21	2.56	1.07				
NW¼NE¼ sec. 10, T. 81 N., R. 22 W., Washington Township. Samples taken from pit 100 feet south of east-west gravel road.	AB	13–17	30.0	14.4	25.7	29.9	5.2	6.6	.11						
	B_{g1}	17–22	41.5	13.2	19.0	26.3	12.9	6.8	.12	1.92	1.23				
	B_{g2}	22–27	41.3	16.8	17.4	24.5	8.4	6.9	.17	.63	1.29				
	B_{g3}	27–31	43.5	14.8	17.0	24.7	4.4	7.1	.06	1.17					
	C_g	31–40	42.8	16.5	17.1	23.6	5.8	7.2	.10	.89	1.30				
	D	40–54	82.9	4.8	5.2	7.1	38.2	7.4	.21						
Nicollet loam	A_h	0–13	41.0	17.6	17.0	24.4	<1.0	6.2	.53	2.36	1.19	13.3	3.8	.26	21.6
SW¼SW¼ sec. 12, T. 80 N., R. 24 W., Crocker Township. Samples taken from pit in field about 250 feet east and 50 feet north of State Highway No. 60.	AB	13–17	43.3	16.0	15.7	25.0	<1.0	5.9	.50	1.97		12.7	3.5	.26	18.7
	B_{21}	17–23	43.5	15.9	14.8	25.8	<1.0	6.2	.55	1.68	1.23	13.5	3.5	.26	17.4
	B_{22}	23–30	46.2	12.4	15.7	25.7	3.0	6.9	.49	1.00	1.23	12.7	3.8	.24	17.2
	B_3	30–33	48.1	12.5	15.7	23.7	8.0	6.8	.45	.90	1.25				
	C_1	33–40	57.2	9.1	13.4	20.3	7.0	7.0	.40		1.39	10.7	3.5	.20	14.6
	C_2	40–60	57.4	9.8	16.7	16.1	9.0	8.0	.38						
Sharpsburg silt loam [2]	A_p	0–10	2.0	34.4	33.1	30.5	0	6.4	.75	2.44		16.6	3.2	.8	27.3
NE¼SE¼SW¼ sec. 26, T. 78 N., R. 25 W., Bloomfield Township. Samples taken from pit 1,000 feet north and 75 feet west of road junction on south section line.	AB	10–13	1.4	32.1	33.7	32.8	0	5.2		2.21		13.3	3.6	.6	27.2
	B_1	13–18	1.4	30.2	32.8	35.6	0	5.6	.88	1.74		13.7	4.9	.6	28.4
	B_{21}	18–22	1.2	29.0	33.9	35.9	0	5.6	.83	1.30		14.0	5.7	.6	29.4
	B_{22}	22–25	1.4	28.4	33.2	37.0	0	5.6	1.00	1.08		14.6	6.7	.5	29.8
	B_{23}	25–29	1.1	27.8	34.6	36.5	0	5.6		.77		14.9	7.2	.5	29.7
	B_3	29–33	1.4	29.8	33.8	35.0	0	5.7	.81	.60		14.9	7.4	.5	29.9
	C_{11}	33–48	1.8	32.5	31.7	34.0	0	5.8	.82	.34		15.0	7.4	.5	28.7
	C_{12}	48–60	1.4	33.8	32.5	32.3	0	5.9		.32		15.2	7.2	.5	27.9

	A_p	0–9	6.8	31.7	27.2	34.3	0	5.6	-------	1.72	1.26	12.8	6.2	.64	26.4
T. 78 N., R. 22 W.,	B_{11}	9–13	10.0	25.7	26.9	37.4	0	5.6	-------	1.49	-------	-------	-------	-------	-------
Samples taken from	B_{12}	13–17	5.5	28.9	28.6	37.0	0	5.7	-------	.91	1.08	13.3	7.2	.54	28.0
t west and 100 feet	B_{21}	17–21	7.4	27.6	29.1	35.9	0	5.7	-------	.69	1.08	13.6	7.2	.54	27.6
ction at midpoint of	B_{22}	21–25	7.5	29.8	30.0	32.7	0	5.9	-------	.66	1.23	13.3	7.0	.52	27.4
	B_3	25–29	8.8	31.4	30.0	29.8	0	6.0	-------	.45	-------	-------	-------	-------	-------
	C_{11}	29–42	9.8	29.3	32.2	28.7	0	6.1	-------	.41	1.20	13.3	7.0	.47	23.0
	C_{12}	42–60	10.5	31.9	31.4	26.2	0	6.3	-------	.29	-------	15.4	8.0	.44	22.5
oderately deep over															
l [2]	A_p	0–8	48.4	16.5	17.3	17.8	4.0	5.8	-------	2.05	-------	-------	-------	-------	-------
sec. 13, T. 80 N.,	AB	8–11	44.0	15.5	18.0	21.5	2.0	5.9	-------	1.44	-------	-------	-------	-------	-------
n Township. Sam-	B_1	11–16	47.6	14.8	17.0	20.6	2.0	5.8	-------	1.38	-------	-------	-------	-------	-------
pit 50 feet north of	B_2	16–22	51.9	12.7	15.5	19.9	4.0	5.6	-------	1.05	-------	-------	-------	-------	-------
oad, about 300 feet	D_1	22–25	62.0	8.6	11.2	18.2	68.0	5.6	-------	.73	-------	-------	-------	-------	-------
hich this road bends.	D_2	25–36	91.9	1.9	2.6	3.6	34.0	6.9	-------	.24	-------	-------	-------	-------	-------
leep over sand and															
	A_p	0–8	31.2	33.2	17.4	18.2	<1.0	5.5	.68	2.07	1.28	-------	-------	-------	-------
¼ sec. 10, T. 81 N.,	AB	8–12	31.4	32.0	17.8	18.8	<1.0	5.3	-------	1.86	-------	-------	-------	-------	-------
shington Township.	B_1	12–15	41.9	21.6	16.8	19.7	<1.0	5.5	.96	-------	-------	-------	-------	-------	-------
m pit in edge of field	B_{21}	15–19	43.6	20.3	15.1	21.0	<1.0	5.5	-------	1.78	1.16	-------	-------	-------	-------
uth of Indian Creek	B_{22}	19–22	42.5	22.3	15.2	20.0	<1.0	5.4	1.30	1.63	1.12	-------	-------	-------	-------
the west section line	B_{31}	22–28	41.4	23.3	14.8	20.5	<1.0	5.2	1.36	1.22	-------	-------	-------	-------	-------
uth of the northern	B_{32}	28–34	43.4	23.1	13.6	19.9	<1.0	5.1	-------	.81	1.15	-------	-------	-------	-------
W¼ sec. 10.	C	34–40	45.9	21.8	14.2	18.1	2.0	5.3	1.45	-------	-------	-------	-------	-------	-------
	D	40–78	75.8	6.4	5.2	12.6	8.0	5.4	-------	-------	-------	-------	-------	-------	-------

J. McCracken unless otherwise indicated.
ICATION IN POLK COUNTY, IOWA, unpublished
McCracken, 1956. Copy on file in Iowa State
, Ames.

[2] Analysis by Soil Survey Laboratory, U. S. Dept. of Agriculture, Beltsville, Maryland.

Adair clay loam

A_p 0 to 7 inches, very dark grayish-brown (10YR 3/2) clay loam to silt loam; moderate, fine and medium, granular structure; slightly firm to friable; medium acid to strongly acid; range, 6 to 12 inches.

B_1 7 to 14 inches, very dark grayish-brown (10YR 3/2) and dark grayish-brown (2.5Y 4/2) clay loam; weak, subangular blocky structure that breaks readily to granular structure; firm; medium acid to strongly acid; range, 3 to 6 inches.

B_2 14 to 30 inches, dark grayish-brown (10YR 4/2) and very dark gray (10YR 3/1) gritty silty clay to "heavy" clay loam; moderate, medium, subangular blocky structure; common, coarse mottles of reddish yellow (7.5YR

A_2 8 to 12 inches, very dark gray (10YR 3/1) silt loam; prominent coatings of dark grayish brown (10YR 4/2) and dark gray (10YR 4/1); friable; weak, coarse, granular structure; medium acid; range, 2 to 6 inches.

B_1 12 to 16 inches, very dark grayish-brown (10YR 3/2 and 2.5Y 3/2) light silty clay loam mottled with olive brown (2.5Y 4/4); very weak, fine and medium, subangular blocky structure; firm; medium acid; range, 2 to 4 inches.

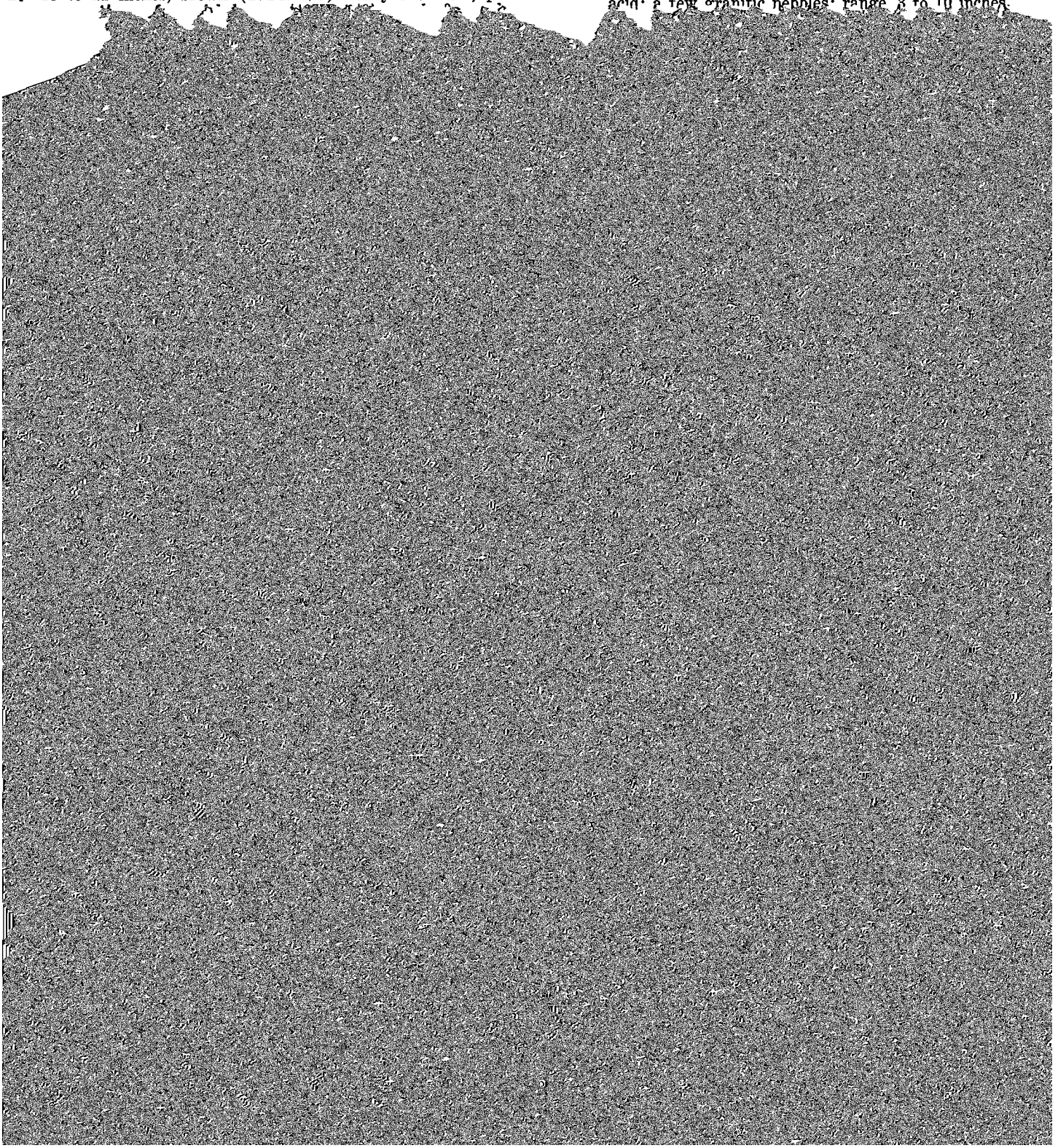
B_2 16 to 26 inches, dark grayish-brown (10YR 4/2 and 2.5Y 4/2) silty clay loam; common, fine and coarse mottles of yellowish brown (10YR 5/6); weak, fine and medium, subangular blocky structure; firm; clay films on aggregates; medium acid; range, 8 to 15 inches.

B_3 26 to 30 inches, dark grayish-brown (10YR 4/2 and 2.5Y

medium, granular structure; friable; slightly acid; range, 3 to 15 inches.

A_2 10 to 18 inches, grayish-brown (10YR 5/2 and 2.5Y 5/2) and brown (10YR 5/3) silt loam; weak, medium, granular structure; friable; medium acid; range, 6 to 9 inches.

B_1 18 to 21 inches, brown (10YR 5/3) heavy silt loam; ped



blocky structure; very firm; medium acid to slightly acid.

Clarion loam

A_p 0 to 7 inches, very dark brown (10YR 2/2) loam; moderate, medium, granular structure; friable; slightly acid; a few granitic pebbles; range, 3 to 10 inches.

Cooper silt loam, acid variant

A_1 0 to 10 inches, very dark gray (10YR 3/1) silt loam; moderate, medium, granular structure; friable; slightly acid; range, 9 to 18 inches.

A_3 10 to 15 inches, very dark grayish-brown (10YR 3/2) silt loam; nearly continuous ped coatings of very dark gray (10YR 3/1); weak, medium, subangular blocky structure that breaks to granular structure; friable; slightly acid; range, 0 to 6 inches.

B_1 15 to 20 inches, very dark grayish-brown (10YR 3/2) silty clay loam; some coatings of very dark gray (10YR 3/1); moderate, medium, subangular blocky structure; firm; slightly acid; range, 3 to 6 inches.

B_2 20 to 29 inches, very dark grayish-brown (10YR 3/2) and some very dark brown (10YR 2/2) silty clay loam; moderate, medium, subangular blocky structure; some thin, discontinuous clay skins; firm; slightly acid; range, 9 to 18 inches.

B_{2b} 29 to 36 inches, dark grayish-brown (10YR 4/2) silty clay; coatings of very dark gray (10YR 3/1); common, fine mottles of reddish yellow (7.5YR 6/6); very friable; considerable gravel; slightly acid; range, 3 to 6 inches.

C_1 33 to 36 inches, yellowish-brown (10YR 5/6) sandy loam; some spots of pale brown (10YR 6/3); single grain; very friable to loose; some gravel and small stones; neutral; range, 0 to 24 inches.

C_2 36 to 48 inches, yellowish-brown (10YR 5/6) and pale-brown (10YR 6/3) sandy loam to loamy sand; single grain; loose; some gravel and small stones; calcareous; mildly alkaline.

Dickinson sandy loam, bench position

A_p 0 to 7 inches, very dark grayish-brown (10YR 3/2) sandy loam; ped coatings of very dark brown (10YR 2/2); weak, coarse, granular structure; very friable; slightly acid; range, 4 to 10 inches.

B_1 7 to 12 inches, dark-brown (10YR 3/3) sandy loam; coatings of very dark brown (10YR 2/2); weak, coarse, granular structure; very friable; slightly acid to medium acid; range, 2 to 5 inches.

B_2 12 to 25 inches, dark-brown (10YR 3/3 and 7.5YR 3/2)

C_{11} 32 to 42 inches, yellowish-brown (10YR 5/4) heavy silt loam; common, fine and medium mottles of pale brown (10YR 6/3) and light brownish gray (10YR 6/2); some thin coatings of dark brown (10YR 3/3) along cleavage planes, which may contain manganese; massive with some vertical cleavage; a few iron-rich "pipestem" concretions of 2 to 5 millimeters in diameter; slightly acid.

C_{12} 42 to 60 inches, mottled yellowish-brown (10YR 5/4), light brownish-gray (10YR 6/2), and dark grayish-brown (10YR 4/2) silt loam; common, iron-rich "pipestems"; massive; friable; slightly acid to neutral or mildly alkaline in lower part.

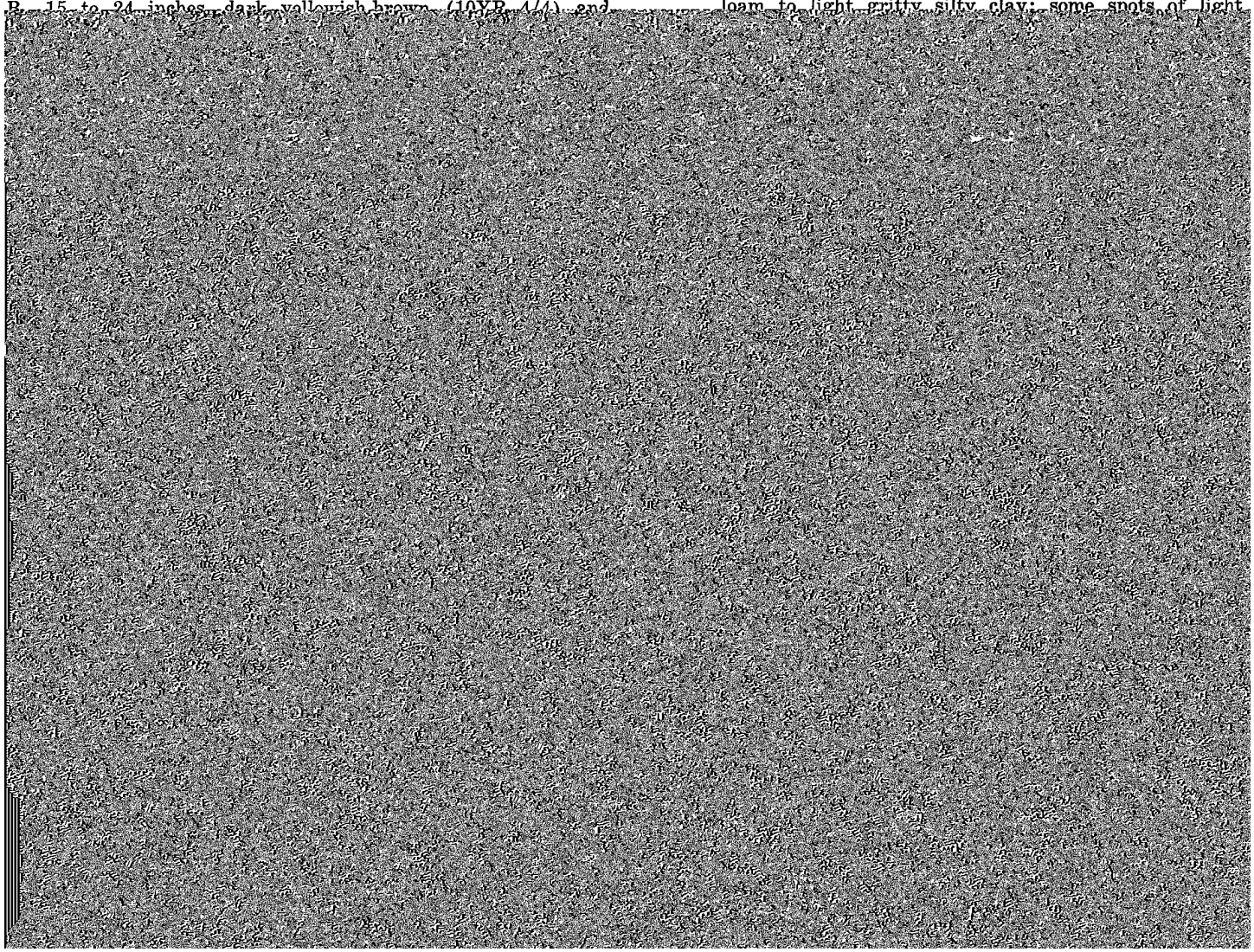
Farrar fine sandy loam

A_p 0 to 6 inches, very dark brown (10YR 2/2) fine sandy loam; weak, fine and medium, granular structure; very friable; medium acid to slightly acid; range, 4 to 8 inches.

A_3 6 to 9 inches, very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) fine sandy loam; weak, fine and medium, granular structure; very friable; medium acid to slightly acid; range, 0 to 6 inches.

B_1 9 to 15 inches, dark-brown (10YR 3/3) fine sandy loam; common, thin ped coatings of very dark brown (10YR 2/2), especially in upper part of horizon; weak, fine and medium, subangular blocky structure; friable; slightly acid to medium acid; range, 3 to 6 inches.

B_2 15 to 24 inches, dark yellowish-brown (10YR 4/4) and



6/3) heavy silt loam; coatings of light brownish gray (2.5Y 6/2) on vertical cleavages; common mottles of reddish yellow (7.5YR 6/6); massive; friable; numerous, soft, fine concretions, apparently ferromanganese; slightly acid; range, 6 to 18 inches.

C_{12} 42 to 60 inches, mottled yellowish-brown (10YR 5/6), light yellowish-brown (10YR 6/4), and pale-brown (10YR 6/3) silt loam; numerous, reddish-yellow (7.5YR 6/6) mottles; massive; friable; common, iron-rich "pipestems," 2 to 5 millimeters in diameter; common, fine and medium-sized concretions, apparently ferromanganese; slightly acid to neutral.

Gara loam

A_p 0 to 5 inches, very dark gray (10YR 3/1) loam; weak, medium, granular structure; friable; medium acid; range, 4 to 8 inches.

A_2 5 to 8 inches, dark grayish-brown (10YR 4/2) loam; numerous, nearly continuous coatings of light brownish gray (10YR 6/2); very weak, coarse, platy structure breaking to weak, medium and coarse, granular structure; friable; medium acid to strongly acid; range, 2 to 6 inches.

B_1 8 to 12 inches, brown (10YR 4/3) light clay loam; common, thin coatings of light brownish gray (10YR 6/2); weak, fine and medium, subangular blocky structure; firm; medium acid; range, 2 to 6 inches.

B_2 12 to 24 inches, yellowish-brown (10YR 5/4) heavy clay loam to light gritty silty clay; some spots of light

C 15 to 36 inches +, yellowish-brown (10YR 5/4) and light brownish-gray (10YR 6/2) silty clay loam to silty clay; common variegations of reddish brown (5YR 5/4); numerous shale fragments; massive, except for shale bedding; medium acid to strongly acid.

Gravity silty clay loam

A_1 0 to 10 inches, very dark grayish-brown (10YR 3/2) silty clay loam; moderate, medium and coarse, granular structure; firm to friable; slightly acid; range, 8 to 12 inches.

A_3 10 to 16 inches, very dark grayish-brown (10YR 3/2) and dark grayish-brown (10YR 4/2) silty clay loam; weak to moderate, medium, subangular blocky structure; firm; slightly acid; range, 3 to 6 inches.

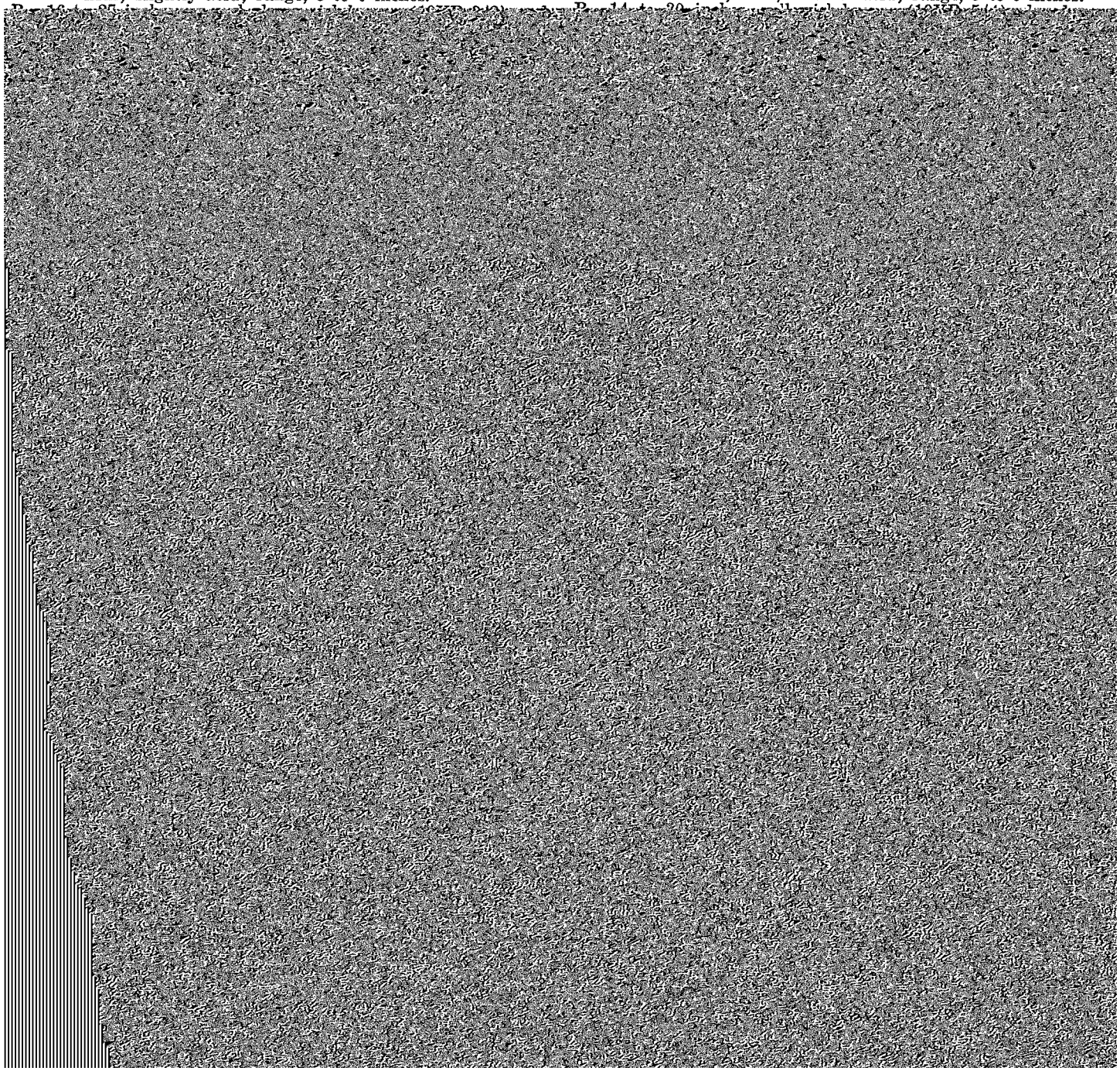
massive; friable; calcium carbonate (lime) concretions are common; a few dark concretions, apparently ferromanganese; calcareous.

Hayden loam

A_1 0 to 2 inches, very dark grayish-brown (10YR 3/2) loam; weak, medium, granular structure; very friable; slightly acid; range, 2 to 4 inches.

A_2 2 to 8 inches, brown (10YR 5/3) to pale-brown (10YR 6/3) loam; weak, fine, platy structure; very friable; medium acid to slightly acid; range, 3 to 9 inches.

B_1 8 to 14 inches, dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) loam; ped coatings of pale brown (10YR 6/3); moderate, medium, subangular blocky structure; firm; medium acid; range, 3 to 6 inches.



lower part of horizon has a few faint mottles; weak, subangular blocky structure that breaks readily to granular structure; friable to slightly firm; slightly acid; range, 12 to 18 inches.

C 36 to 45 inches, dark grayish-brown (10YR 4/2) and dark-brown (10YR 4/3) silt loam; massive; friable; slightly acid to mildly alkaline.

Kato loam, deep over sand and gravel

A_p 0 to 8 inches, very dark gray (10YR 3/1) to very dark brown (10YR 2/2) silt loam to light silty clay loam; moderate, medium, granular structure; friable; slightly acid; range, 4 to 8 inches.

A_{12} 8 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; slightly acid to medium acid; range, 4 to 8 inches.

B_1 14 to 20 inches, very dark grayish-brown (10YR 3/2 to 2.5Y 3/2) heavy silt loam or loam; very weak, subangular blocky structure that breaks readily to medium, granular structure; friable; medium acid; range, 4 to 8 inches.

B_2 20 to 32 inches, very dark grayish-brown (10YR 3/2) heavy silt loam to loam; a few mottles of dark gray (10YR 4/1) and yellowish brown (10YR 5/4); weak, medium, subangular blocky structure; friable; medium acid; range, 10 to 16 inches.

B_3 18 to 22 inches, brown (10YR 4/3) and yellowish-brown (10YR 5/4) gravelly sandy loam; very weak, subangular blocky structure to massive; friable; slightly acid to mildly alkaline; range, 0 to 4 inches.

D 22 to 36 inches +, yellowish-brown (10YR 5/4) and pale-brown (10YR 6/3) gravelly sandy loam; single grain; loose; calcareous to mildly alkaline; below a depth of 36 inches, material is mostly gravel.

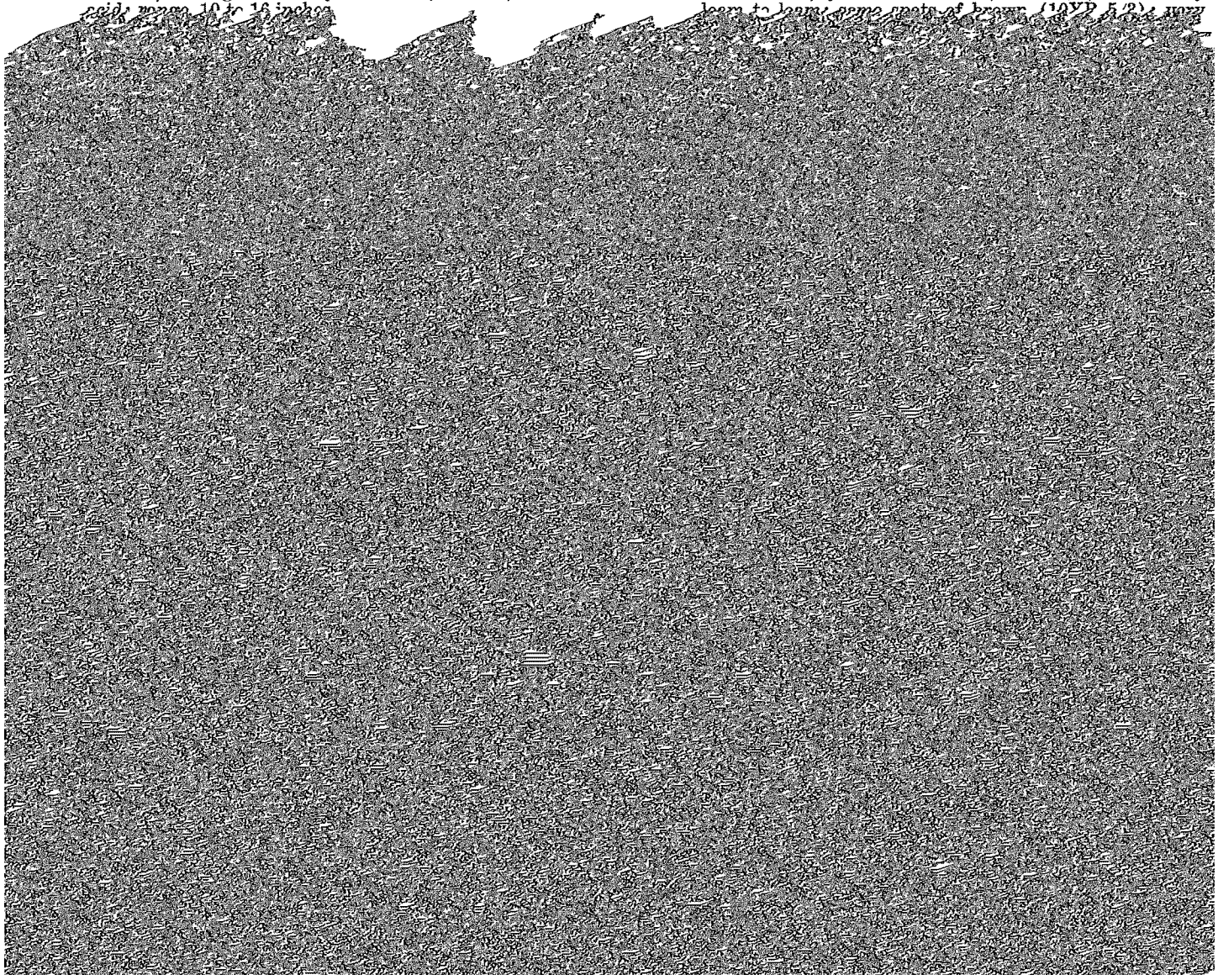
Lamont fine sandy loam

A_1 0 to 4 inches, very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) fine sandy loam; weak, coarse, granular structure; very friable; slightly acid; range, 0 to 4 inches.

A_2 4 to 8 inches, dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) fine sandy loam; thin, nearly continuous coatings of dark gray (10YR 4/1); very weak, coarse, granular structure; very friable; medium acid; range, 2 to 9 inches.

B_1 8 to 12 inches, yellowish-brown (10YR 5/4) fine sandy loam; thin, discontinuous coatings of grayish brown (10YR 5/2); very weak, medium, subangular blocky structure; very friable; medium acid; range, 2 to 4 inches.

B_2 12 to 24 inches, yellowish-brown (10YR 5/4) fine sandy loam to loam; some coats of brown (10YR 5/3); very

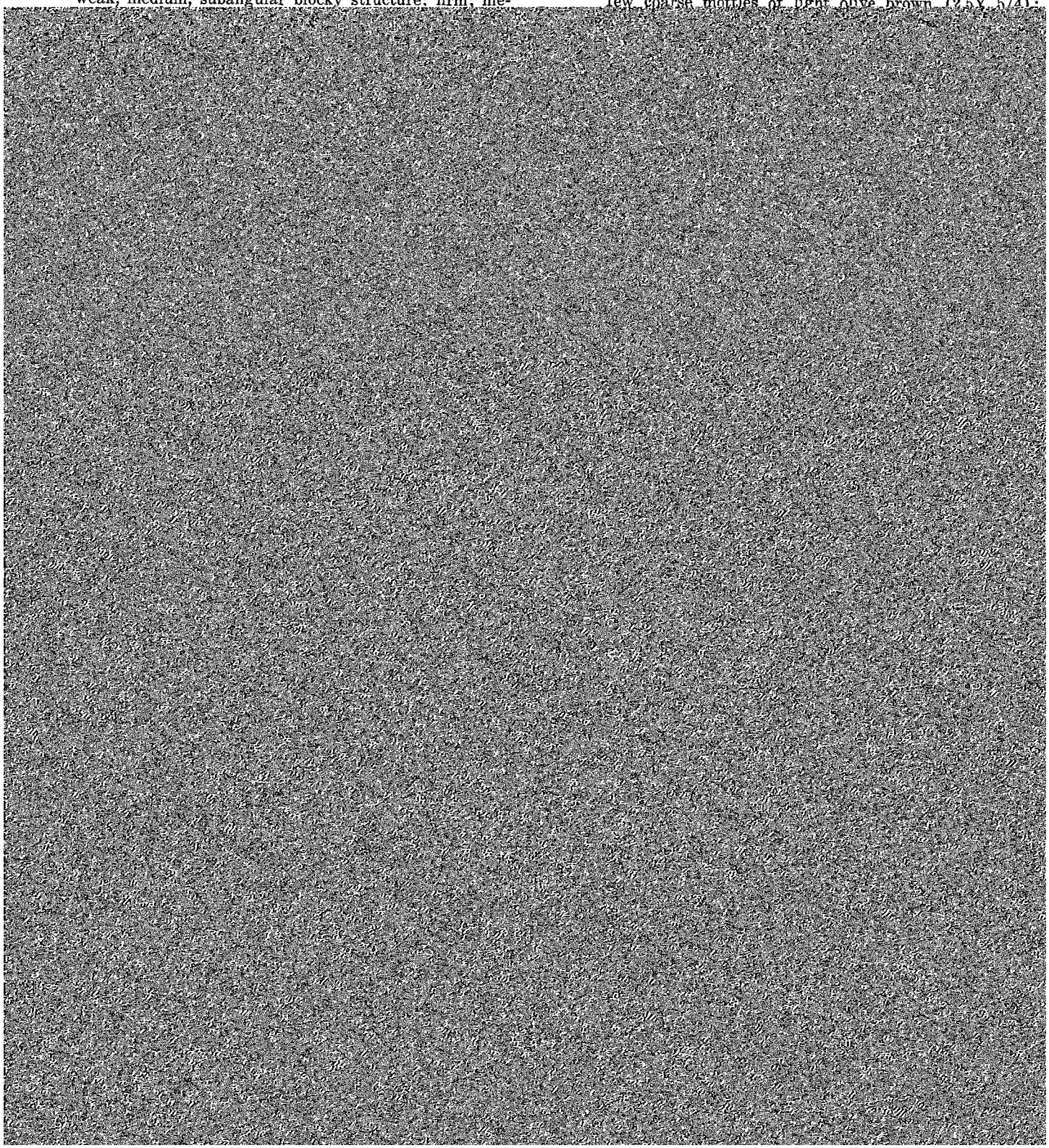


A_3 11 to 15 inches, very dark grayish-brown (10YR 3/2) loam; coatings of very dark gray (10YR 3/1); weak, medium, granular structure; friable; medium acid to slightly acid; range, 2 to 4 inches.

B_1 15 to 20 inches, very dark grayish-brown (10YR 3/2) light clay loam; a few spots of strong brown (7.5YR 5/6); weak, medium, subangular blocky structure; firm; me-

loam; a few coarse mottles of light olive brown (2.5Y 5/4) and some thin coatings of black (10YR 2/1); weak, medium, subangular blocky structure; firm; slightly acid; range, 5 to 10 inches.

B_{g2} 28 to 32 inches, very dark grayish-brown (2.5Y 3/2) and olive-gray (5Y 4/2) silty clay loam or clay loam; a few coarse mottles of light olive brown (2.5Y 5/4);



B_2 17 to 29 inches, very dark grayish-brown (10YR 3/2) and dark grayish-brown (10YR 4/2) heavy loam to light clay loam; common, fine mottles and spots of yellowish brown (10YR 5/4) and some thin, discontinuous ped coatings of very dark gray (10YR 3/1); moderate, fine and medium, subangular blocky structure; slightly firm; slightly acid; a few pebbles; range, 9 to 15 inches.

B_3 29 to 33 inches, dark-brown (10YR 4/3) and dark grayish-brown (10YR 4/2) heavy loam; common, medium spots and mottles of yellowish brown (10YR 5/4); very weak, medium, subangular blocky structure; friable; slightly acid; a few pebbles; range, 3 to 6 inches.

C_1 33 to 36 inches, yellowish-brown (10YR 5/4) loam; mottles of pale brown (10YR 6/3) and strong brown (7.5YR 5/6); massive; friable; neutral to mildly alkaline; a few pebbles; range, 0 to 12 inches.

C_2 36 to 48 inches, mottled yellowish-brown (10YR 5/4), light brownish-gray (10YR 6/2), and strong-brown (7.5YR 5/6) loam; massive; friable; lime concretions; calcareous; considerable gravel and a few cobblestones.

Nodaway silt loam

A_p 0 to 8 inches, dark grayish-brown (10YR 4/2) to very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable; medium acid to slightly acid; range, 6 to 9 inches.

A_3 8 to 15 inches, dark grayish-brown (10YR 4/2) and brown (10YR 5/3) silt loam; weak, medium and fine, granular structure; friable; medium acid to slightly acid; range, 6 to 9 inches.

C_1 15 to 30 inches, dark grayish-brown (10YR 4/2) silt loam; prominent, medium mottles of strong brown (7.5YR 5/6); massive; friable; medium acid to slightly acid; range, 12 to 36 inches.

D (or A_{1b}) 30 to 45 inches +, black (10YR 2/1) to very dark gray (10YR 3/1) silty clay loam; mottles of strong brown (7.5YR 5/6) in lower part; weak, granular structure to massive; firm; slightly acid to medium acid.

Okoboji silt loam

A_1 0 to 25 inches, black (10YR 2/1) silt loam to mucky silt loam; weak, medium and fine, granular structure; friable; neutral to mildly alkaline; range, 15 to 30 inches.

B_{1g} 25 to 35 inches, dark grayish-brown (2.5Y 4/2) to grayish-brown (2.5Y 5/2) silt loam; coarse mottles of olive brown (2.5YR 4/4); very weak, medium, subangular blocky structure to massive; friable to slightly firm; calcareous; mildly alkaline; a few fine to medium-sized iron concretions.

C_g 35 to 45 inches, mottled grayish-brown (2.5Y 5/2), olive-brown (2.5Y 4/4), and dark olive-gray (5Y 3/2) silt loam to silty clay loam; massive; friable; calcareous; some fine and medium-sized iron concretions.

Olmitz loam

A_1 0 to 20 inches, very dark brown (10YR 2/2) loam; weak, medium, granular structure; friable; medium acid; range, 9 to 20 inches.

B_{1-2} 20 to 30 inches, dark grayish-brown (10YR 4/2) and dark-brown (10YR 4/3) loam; very weak, fine and medium, subangular blocky structure; medium acid; range, 9 to 15 inches.

C 30 to 50 inches, grayish-brown (10YR 5/2), light brownish-gray (10YR 6/2), and dark-brown (10YR 4/3) loam; massive; friable; medium acid to slightly acid.

Rolfe loam

A_1 12 to 16 inches, very dark-gray (10YR 3/1) heavy loam to light clay loam; some ped coatings of black (10YR 2/1); weak, fine, subangular blocky structure; firm; medium acid to slightly acid; range, 3 to 6 inches.

B_{2g} 16 to 27 inches, dark-gray (10YR 4/1) and very dark grayish-brown (2.5Y 3/2) clay loam to silty clay loam or silty clay; some thin, discontinuous coatings of black (10YR 2/1); moderate, fine and medium, subangular blocky structure; thin, discontinuous clay skins; very firm to firm; medium acid to slightly acid; range, 9 to 15 inches.

B_3 27 to 33 inches, dark olive-gray (5Y 3/2) clay loam mottled with very dark grayish brown (2.5Y 3/2); a few coatings and spots of black (10YR 2/1); moderate, fine and medium, subangular blocky structure; firm; slightly acid to medium acid; range, 3 to 6 inches.

C_1 33 to 48 inches +, dark olive-gray (5Y 3/2) light clay loam to heavy loam; common, fine mottles of yellowish brown (10YR 5/6); massive; firm; slightly acid to neutral.

Runnells silt loam

A_1 0 to 5 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable; slightly acid; range, 4 to 10 inches. The A_p horizon, or plow layer, is dark grayish brown (10YR 4/2) to very dark grayish brown (10YR 3/2).

A_2 5 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; thin, nearly continuous coatings of grayish brown (10YR 5/2); weak, medium, platy structure that breaks readily to granular structure; friable; medium acid; range, 2 to 6 inches.

B_1 8 to 12 inches, dark-brown (10YR 4/3) light silty clay loam to heavy silt loam; common, thin, discontinuous coatings of dark grayish-brown (10YR 4/2) and common spots of yellowish brown (10YR 5/4); weak, medium, subangular blocky structure; firm; medium acid; range, 3 to 6 inches.

B_2 12 to 20 inches, yellowish-brown (10YR 5/4) to brown (10YR 5/3) light silty clay loam; moderate, medium, subangular blocky structure; firm; a few thin, discontinuous clay skins; medium acid; range, 6 to 18 inches.

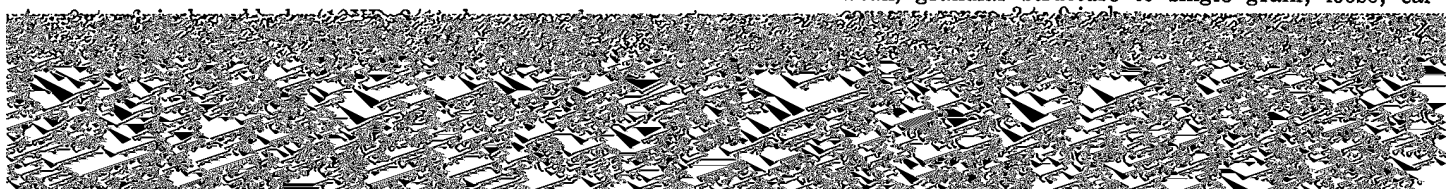
B_{2u} 20 to 27 inches, yellowish-brown (10YR 5/4) gritty silty clay loam to clay loam; common, thin coatings of brown (7.5YR 4/4); moderate, medium, subangular blocky structure; firm; common, thin, discontinuous clay skins; a few hard concretions, 1 to 2 millimeters in diameter; gravel is common; medium acid; range, 0 to 9 inches. (This horizon seems to have developed from loess mixed with Kansan till, shale, or both.)

B_{3u} 27 to 32 inches, yellowish-brown (10YR 5/4) to brown (7.5YR 5/4) clay loam to silty clay; coatings of dark brown (10YR 4/3) with a few coarse variegations of reddish brown (5YR 5/4); weak, coarse, subangular blocky structure; very firm; a few thin, discontinuous clay skins; common, hard, dark concretions, 1 to 2 millimeters in diameter; gravel common; medium acid; range, 3 to 6 inches.

C_u 32 to 48 inches +, yellowish-brown (10YR 5/4) to dark yellowish-brown (10YR 4/4) and light brownish-gray (10YR 6/2) silty clay or clay; a few coarse variegations of reddish brown (5YR 5/4); massive; very firm; medium acid to strongly acid; common, hard, dark concretions; some gravel.

Sarpy loamy sand

A_1 0 to 6 inches, grayish-brown (10YR 5/2) loamy sand; very weak, granular structure to single grain; loose; cal-

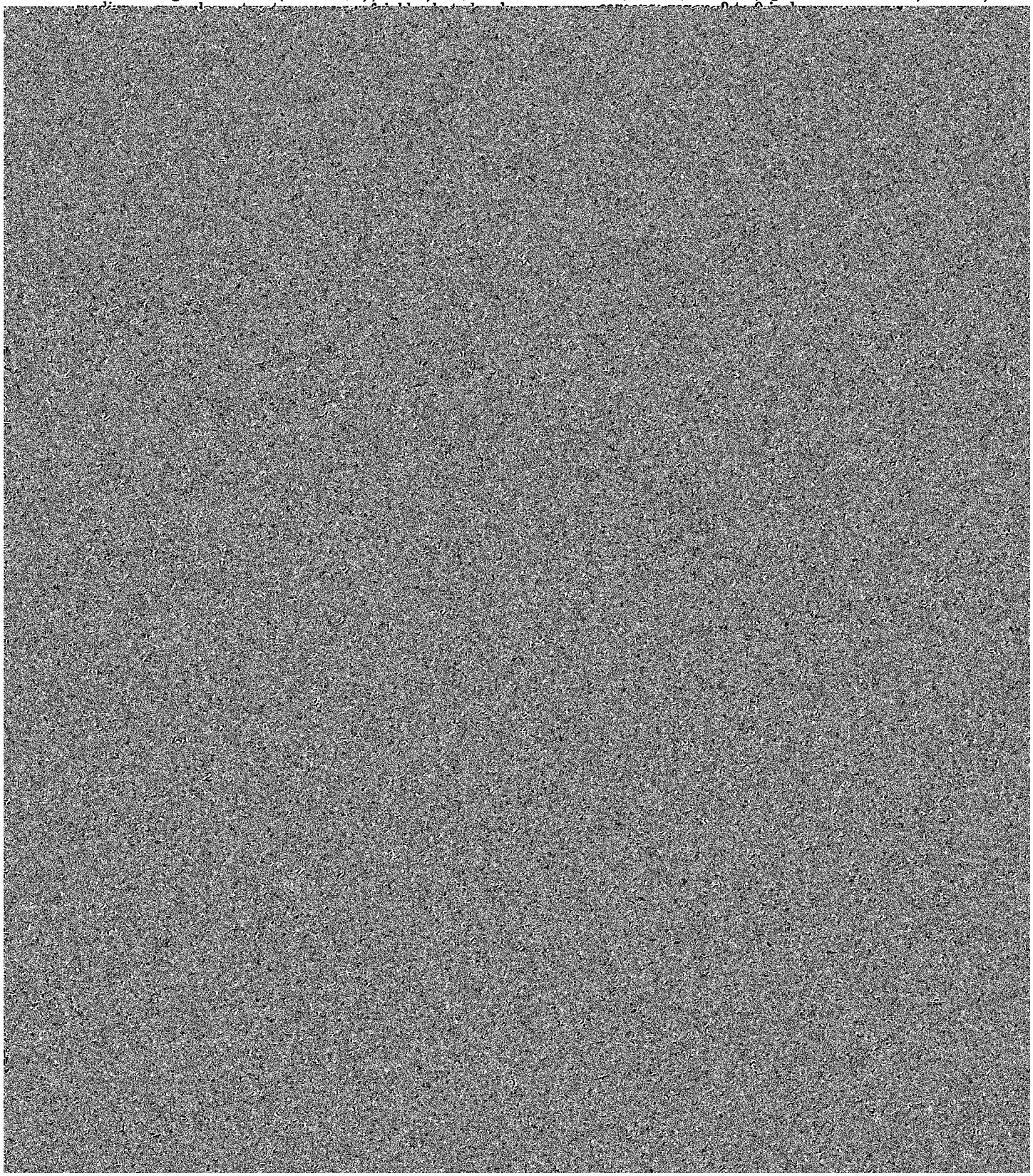


Saylor fine sandy loam

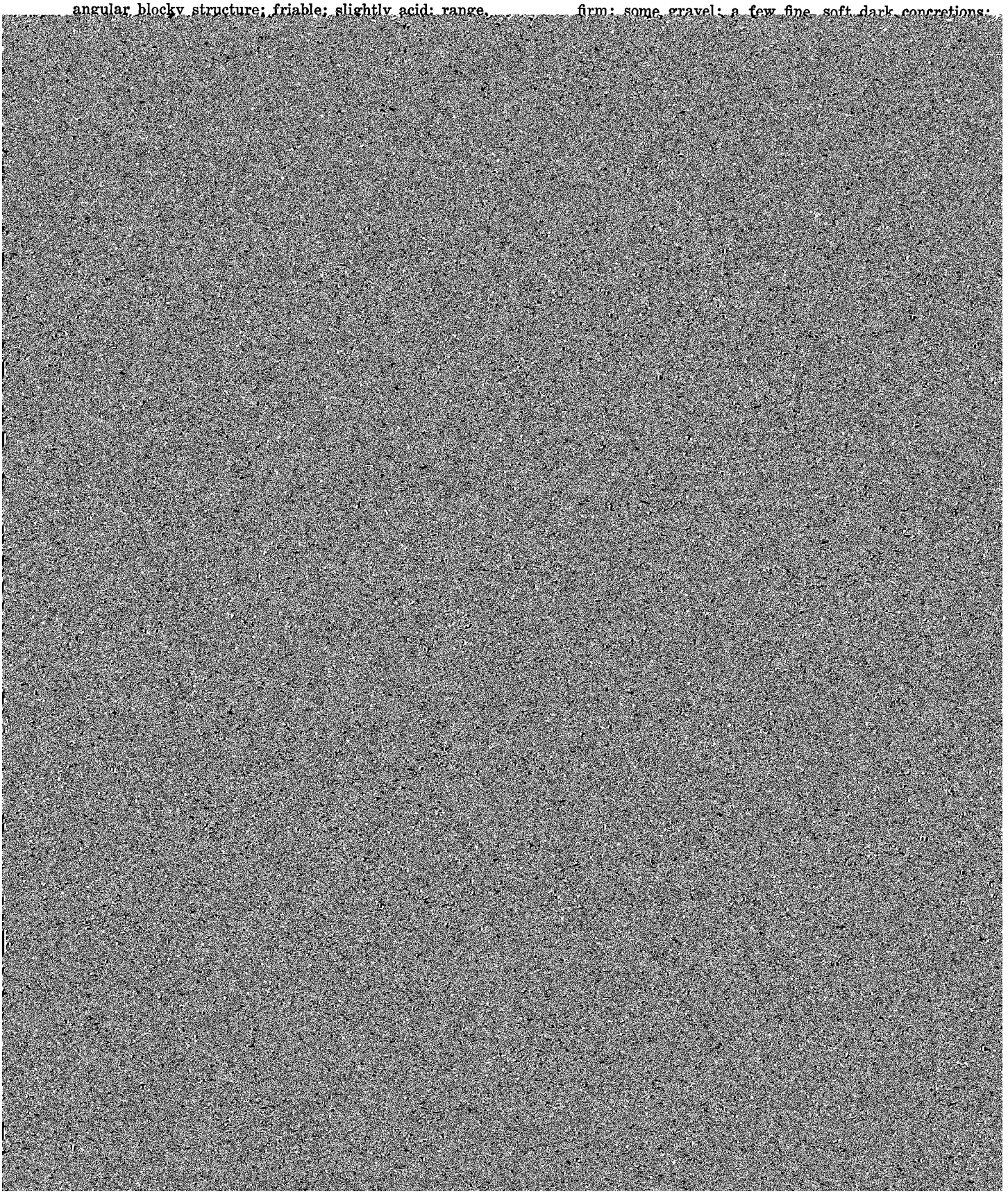
A_1 0 to 12 inches, very dark gray (10YR 3/1) fine sandy loam; some coatings of black (10YR 2/1); weak, fine and

Storden loam

A_1 0 to 6 inches, very dark grayish-brown (10YR 3/2) loam; very weak, medium, granular structure; friable; cal-



angular blocky structure; friable; slightly acid; range. firm; some gravel; a few fine soft dark concretions;



Soil: The natural medium for the growth of land plants on the surface of the earth; composed of organic and mineral materials.

Topsoil: Presumably fertile soil material used to topdress roadbanks, gardens, and lawns.

Engineering Classification Systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (*1*). In this system soil materials are classified in seven principal groups. The groups range from A-1, consisting of gravelly soils of high-bearing capacity, to A-7, which is made up of clay soils having low strength when wet. The group symbols for the Polk County soils are shown in the next to last column in table 6.

Some engineers prefer to use the Unified soil classification system (*20*). In this system, soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. An approximate classification can be made in the field. The classification of the soils in Polk County is given in the last column of table 6.

Basic engineering and soil information can be obtained from the PCA Soil Primer (*9*).

Soil Engineering Data and Interpretations

Some of the information needed by engineers can be obtained from the soil map. For more detailed information and for a better understanding of the general conditions in the area, it will be necessary to refer to other parts of the report, particularly to these sections: General Nature of the County; Soil Survey Methods and Definitions; General Soil Areas of Polk County; Descriptions of Soils; and Genesis, Morphology, and Classification of Soils.

The soil engineering data in table 6 are based on soil test data of Iowa State Highway Commission, on information given in the other sections of the report, and on experience with the same kinds of soils in other counties.

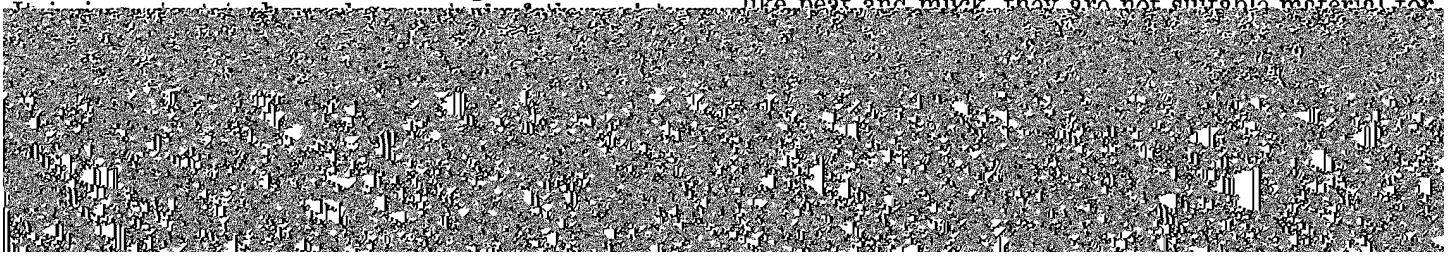
The bedrock in Polk County is shale of the Des Moines group. It consists of interbedded layers of shale, limestone, sandstone, siltstone, and coal. Normally it is buried beneath several feet of glacial till. Where the bedrock outcropped and weathered, it formed the parent material of the Gosport, Bauer, and Runnells soils. The shale expands when exposed to weathering and breaks up to form plastic clay and silty clay. When these materials are encountered in highway construction, the grade in embankments should be at least 5 feet above them, and, in cut sections, they should be covered with granular material.

In the southern one-fifth of the county, the shale is overlain by Kansan glacial till, which is covered with a loess mantle up to 20 feet thick. The Kansan glacial till is heterogeneous. Under the loess mantle, in the less dissected areas, lies what remains of the original Kansan till plain. In some areas this consists of an upper layer of very stiff, plastic clay, A-7 ("gumbotil"), which is unstable in highway subgrades and should not be used within 5 feet of grade. In other areas where the till-plain surface was more rolling, a reddish-brown, pebbly layer of till formed. Wherever glacial soils outcrop, either the gumbotil or the pebbly layer is ordinarily found near the top. Beneath these interface layers, the soils are predominantly A-7, although because of the method of deposition, any soil texture may occur, from sand and gravel to plastic clay. Frost heaving is common where sand or gravel pockets holding large quantities of free water are overlain by fine-grained soils that are within the zone of frost penetration. A perched water table may be encountered where a layer or pocket of sandy or gravelly soil overlies a layer of clayey soil.

The soils developed from the loess overlying the Kansan till are texturally fine grained (A-6 and A-7 or CL and CH) and fairly uniform in texture throughout their depth. Frost heaving is not normally a problem in loess soils, because of the uniformity of material; however, frost heaving of pavements may occur in cut sections where only a few feet of loess overlies the heterogeneous glacial till. If runoff is concentrated, the soils derived from loess are very erodible. Hence, sod, pavement, or check dams are needed in gutters and ditches to control erosion. The seasonally high water table in the loess soils usually lies above the glacial till-loess interface. The in-place density of the loess is low enough to permit a high moisture content, which may cause instability of slopes steeper than 30 degrees and of embankments placed without moisture and density control.

In the northern four-fifths of Polk County, the soils developed from glacial till of the more recent Cary substage of the Wisconsin glaciation. Although these soils are heterogeneous, like those developed from the Kansan till, they are texturally better for engineering (generally A-4 or A-6). Frost heaving is a greater problem in Cary till, which has more sand and gravel pockets containing free water.

In level to gently rolling soils like the Nicollet and Webster, the dark-colored, thick topsoil is more than 2 percent carbon. Good density is difficult to obtain in this topsoil, even with control of moisture content and compaction. Hence, this topsoil should not be used in the upper 2 feet of a highway embankment. Glencoe and Okoboji soils are excessively high in carbon and, like peat and muck, they are not suitable material for



Many of these deposits are sources of construction materials of high quality. Some areas of the Chelsea, Hagener, and Lamont soils, which formed from eolian sands, are susceptible to wind erosion. Roadway slopes in these soils should be protected from both water and wind erosion.

The alluvial soils of the bottom lands, represented by the Colo, Cooper, Huntsville, Nodaway, Dorchester, and Wabash, are occasionally flooded. Roadways constructed in these bottom lands should be on embankments above the level of flooding. The fine sand and silt layers common in alluvial soils are susceptible to differential frost heave; hence, proper roadway drainage should be provided and foundation materials that are not susceptible to frost action should be used if pavements are constructed only a few feet above the water table. The water table is seasonally variable in these soils, but the moisture content is generally high and in-place density low; therefore, moisture and density control are needed if these soils are used as embankment material.

Table 6 shows the suitability of Polk County soils as sources of borrow for highway construction and as sources of topsoil for embankments, slopes, and ditches. Material suitable for topsoil is generally unsuitable for use on highway shoulders that have to support some traffic during wet periods.

At many construction sites, major variations in the soil may occur within the depth of the proposed excavation. Also, several soil units may occur within short distances. Nevertheless, soil engineers can use the information in soil survey reports to plan detailed surveys of soils at construction sites. This makes it possible to take a minimum number of soil samples for laboratory testing, and to make an adequate soil investigation at minimum cost.

Soil Properties Affecting Soil Conservation Practices

This section discusses soil properties and their relation to terraces, drainage, irrigation, and farm ponds —engineering structures that conserve soil and water.

Terraces

The factors to be considered before building terraces are: (1) the purpose of the terraces, (2) the slope of the land, and (3) the soil conditions. In general, terraces are built for two purposes. The more common of the two is to control sheet and gully erosion on sloping soils; the other is to divert water from lower areas to prevent flooding. Generally, diversion terraces are the larger in cross section and they are always on a grade because they are designed to carry more water.

Terraces may be constructed on any slope on which earth-moving machinery can operate. The steeper the slopes, the larger or closer together the terraces have to be, and consequently the more difficult they are to

had been had with terraces on slopes of more than 18 percent. However, some farmers have built terraces on such slopes in western Iowa and have reported that they are satisfactory.

Controlling gullies is a complicated problem in this county, and practices other than terracing may be needed. Technical service is available from the Soil Conservation Service.

Terraces can be constructed satisfactorily from most soil material unless it is very sandy. Loamy sand, loamy fine sand, sand, or gravel are not likely to make stable terraces. They will tend to drift with the wind or to slump into the terrace channels. On soils like Buckner loamy sand, Chelsea loamy fine sand, Crocker loamy fine sand, and Hagener loamy fine sand, it is hard to keep the channels from filling.

Most of the sloping soils in the uplands of Polk County are suitable for terracing. Graded terraces with outlets to grassed waterways are the most suitable for Polk County soils.

Drainage and irrigation

Artificial drainage of soils to improve crop yields is an important farming practice in this county. Tile drainage with outlets to manmade open ditches or to natural streams is the most common method. Open ditch drainage is second.

Tile drainage systems are installed to remove subsurface water from the soil and, in some cases, to remove surface water through surface intakes. Factors to consider before installing tile drainage are (1) the need for drainage, (2) the suitability of the soil for drainage by tile, (3) the availability of a suitable outlet for the tile, and (4) an adequate design to provide a complete and economical system.

Whether or not tile will work well depends on the permeability of the soil. Tile drains do not work well in soils that are very slowly permeable, except when used to remove surface water through open intakes. Tile drains do work well in soils that are moderately permeable. Tile should be closer together in soils that are slowly permeable than in soils that are moderately permeable and may then work only fairly well.

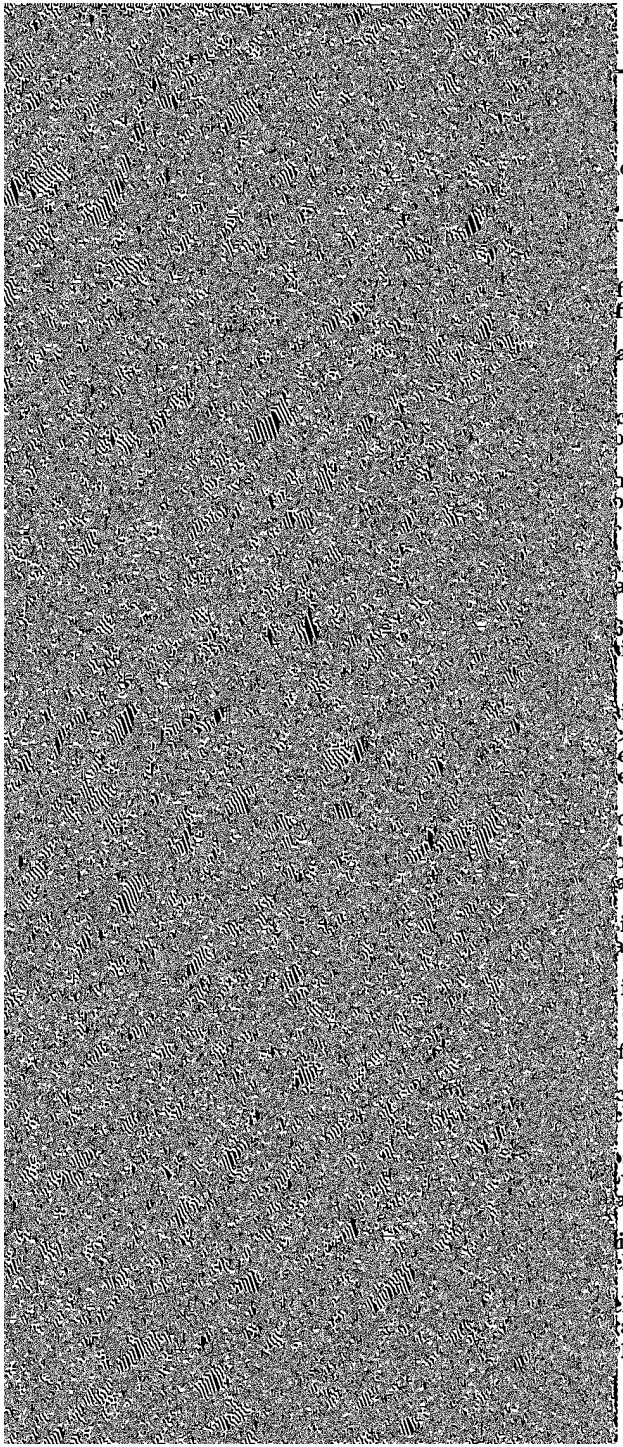
The Clarinda and Adair soils are very slowly permeable, but their principal drainage problem is caused by seepage through the overlying loess. Tile lines placed so as to intercept the seepage water will drain these soils satisfactorily.

Soils having a sand or gravel substratum present special problems of tile installation and maintenance because of their unstable nature.

The drainage and permeability classifications of the soils will be found in table 3, Summary of Major Characteristics of Soil Types.

To determine the suitability of a tile outlet and to get an adequate design for the tile system, the services of a drainage engineer are normally needed.

Open ditches are used to remove excess surface water or to remove water collected by tile or by other



6.—*Soil characteristics that affect engineering*

on	Parent material	Depth to seasonally high water table	Suitability as source of—		Classification	
			Topsoil	Borrow for highway construction	AASHO [1]	Unified [2]
		Feet				
im- firm firm	Kansan glacial till	(3)	Unsuitable	Poor	A–7	CL–CH.
able the	Alluvium	2 to 3	Fair	Fair	A–2 to A–7	SM–CH.
clay over	Cary glacial till	1½ to 3	Fair	Poor	A–7	CH–OH.
ned; over	Local sandy alluvium.	3+	Unsuitable	Good	A–2 or A–3	SP–SM.
im- silty able	Loess	3+	Fair to depth of dark surface layer.	Poor	A–6 or A–7	CL–CH.
5 to silty are	Shale	3+	Poor	Poor (shale unsuitable).	A–6 or A–7 over shale.	CL over shale.
silty con- eet; ent	Alluvium	2 to 3	Fair	Unsuitable	A–7	CH–OH.
ose, igh- ome arly	Glacial outwash	5+	Unsuitable	Good	A–1 or A–2	SW–SP.
silty able	Local alluvium	2½ to 3	Fair	Poor	A–7	CL–CH.
im- silt	Local alluvium	2 to 3	Good	Fair	A–4 to A–6	ML–CL.
fine	Aeolian sands	5+	Unsuitable	Good	A–2 or A–3	SM–SP.
ctly clay	Kansan gumbotil	(3)	Unsuitable	Unsuitable	A–7	CH.
sam over and	Cary glacial till	5+	Good to depth of dark surface layer.	Good	A–4 to A–6	SC–CL.
silty clay	Loess over gumbotil.	(3)	Good to depth of dark surface layer.	Poor	A–7	CL–CH.
clay can- per	Alluvium	1 to 3	Good to depth of 1½ feet.	Unsuitable	A–7	OH–CH.

Cooper	0 to 2 percent.	Imperfectly drained; firm silty clay loam subsoil over very firm silty clay or clay at depths of 24 to 42 inches.	Alluvium	2 to 3	Good to depth of 1½ feet.	Unsuitable	A–7	CL–CH.
Crocker	2 to 30 percent.	Somewhat excessively drained; loose loamy fine sand over slightly firm loam or clay loam at depths of 12 to 24 inches.	Aeolian sands over glacial till.	5+	Unsuitable	Fair	A–2 to A–3 over A–4 to A–6.	SM–SP over SC–CL.
Dickinson	0 to 30 percent.	Well drained to somewhat excessively drained; friable fine sandy loam subsoil; underlying material ranges from a loam to sand.	Sandy Cary glacial drift.	5+	Poor	Good	A–2 to A–4	SM–SC.
Dickinson, bench position.	0 to 9 percent.	Somewhat excessively drained; very friable sandy loam subsoil; below depth of 30 inches, loose loamy sand to sandy loam with some gravel layers.	Glacial outwash	5+	Poor	Excellent	A–1 or A–2	SM–SP.
Dorchester	0 to 2 percent.	Imperfectly drained to excessively drained; friable silt loam; sand below depth of 12 inches.	Alluvium	1 to 3	Good to depth of sand.	Good	A–2 to A–4	SM–SP.
Downs	0 to 30 percent.	Well drained; slightly firm silty clay loam subsoil over friable silt loam.	Loess	5+	Good to depth of dark surface layer.	Fair	A–6 or A–7–6	ML–CL.
Farrar	2 to 30 percent.	Somewhat excessively drained; friable sandy loam subsoil over friable loam.	Aeolian sands over Cary glacial till.	5+	Poor	Good	A–2 to A–4	SM–SC.
Fayette	0 to 40 percent.	Well drained; slightly firm silty clay loam subsoil over friable silt loam.	Loess	5+	Fair to poor	Fair	A–6 or A–7–6	ML–CL.
Gara	5 to 40 percent.	Well drained; very firm to firm clay loam over firm clay loam; contains stones, pebbles, some sand pockets and, in places, some gumbotil-like material.	Cary glacial till	3 to 5+	Fair to depth of dark surface layer.	Fair	A–6 or A–7	CL–CH.
Glencoe	Depressions.	Very poorly drained; firm silty clay loam to silty clay subsoil; high organic-matter content to depths of 2 to 3 feet.	Local alluvium	0 to 3	Fair to good	Unsuitable	A–7	CH–OH.
Gosport	5 to 40 percent.	Well drained; plastic silty clay shale at depths of 6 to 18 inches.	Shale	(3)	Unsuitable	Unsuitable	Visual (shale)	Visual (shale).
Gravity	2 to 4 percent.	Imperfectly drained; firm to friable silty clay loam throughout; high organic-matter content to depths of 1½ to 2 feet.	Local alluvium	2½ to 3	Good	Fair	A–6 or A–7	CL.
Hagener	0 to 20 percent.	Excessively drained; loose loamy fine sand or loamy sand throughout.	Aeolian sands	5+	Unsuitable	Good	A–2 or A–3	SM–SP.
Harpster	1 to 2 percent.	Poorly drained; slightly firm clay loam subsoil over slightly firm loam; high organic-matter content to depths of 1½ feet.	Cary glacial drift	1½ to 3	Poor	Unsuitable	A–6 or A–7	CL–OH.
Hayden	0 to 40 percent.	Well drained; slightly firm clay loam subsoil over friable loam; sand and gravel lenses common.	Cary glacial till	5+	Poor	Good	A–4 to A–6	SC–CL.
Huntsville	0 to 2 percent.	Moderately well drained to imperfectly drained; friable silt loam or sandy loam throughout.	Alluvium	1 to 3	Good	Good	A–2 to A–4	SM–ML.

TABLE 6.—*Soil characteristics that effect engineering—Continued*

Soil series and miscellaneous land types	Slope	Brief description of soil profile and ground condition	Parent material	Depth to seasonally high water table	Suitability as source of—		Classification	
					Topsoil	Borrow for highway construction	AASHO [1]	Unified [2]
				Feet				
Ida	5 to 9 percent.	Well drained; very friable silt loam throughout.	Loess	5+	Poor	Fair	A–4 to A–6	ML–CL.
Judson	2 to 9 percent.	Moderately well drained; friable silt loam throughout; fairly high organic-matter content in top 2 to 3 feet.	Local alluvium	3+	Good	Poor	A–7	OL–CL.
Kato	1 to 3 percent.	Imperfectly drained; slightly firm loam subsoil; sand and gravel at depths of 24 to 36 inches or more.	Glacial outwash	2½ to 3	Good to depth of dark surface layer.	Excellent	A–4 over A–1 or A–2.	SM–SC over SP–SW.
Ladoga	2 to 30 percent.	Well drained; firm silty clay loam subsoil over friable silt loam.	Loess	5+	Good to depth of dark surface layer.	Fair	A–6 or A–7	ML–CL.
Lakeville	2 to 40 percent.	Excessively drained; very friable sandy loam subsoil; loose gravel and sand below depths of about 2 feet.	Cary glacial drift	5+	Unsuitable	Excellent	A–1 or A–2	GP–SW.
Lamont	2 to 30 percent.	Somewhat excessively drained; friable fine sandy loam subsoil; loose fine sandy loam to loamy fine sand below depths of about 2 feet.	Aeolian sands	5+	Unsuitable	Good	A–2 or A–3	SM–SP.
Lester	0 to 40 percent.	Well drained; firm loam to clay loam subsoil over friable loam; sand and gravel lenses common.	Cary glacial till	5+	Fair to depth of dark surface layer.	Good	A–4 to A–6	SC–CL.
LeSueur	1 to 3 percent.	Imperfectly drained; firm clay loam subsoil over friable loam.	Cary glacial till	3+	Fair to depth of dark surface layer.	Fair	A–6 or A–7	CL.
Lindley	9 to 40 percent.	Well drained; very firm, gritty silty clay subsoil over firm clay loam; contains pebbles, stones, sand pockets, and, in places some gumbotil-like material.	Kansan glacial till	3 to 5+	Poor	Fair	A–6 or A–7	CL–CH.
Marshan	0 to 2 percent.	Poorly drained; firm silty clay loam subsoil; stratified sand or gravel below depths of 24 to 60 inches; fairly high organic-matter content to depths of 1½ to 2 feet.	Glacial outwash	1½ to 3	Good to depth of dark surface layer.	Unsuitable above gravel.	A–6 or A–7 over A–1 or A–2.	OH over SP–SW.
Muck	Depressions.	Loose very friable organic material to depths of 6 to 42 inches over firm silty clay loam.	Organic material over glacial drift.	0 to 3	Good	Unsuitable	Visual	Pt.
Muscatine	1 to 3 percent.	Imperfectly drained; slightly firm silty clay loam subsoil over friable silt loam.	Loess	3+	Good	Poor	A–6 or A–7	CL–OL.
Nicollet	1 to 3 percent.	Imperfectly drained; slightly firm clay loam subsoil over friable loam; sand and gravel pockets are common.	Cary glacial till	3+	Good to depth of dark surface layer.	Fair	A–6 or A–7	SC–CL.
Nodaway	0 to 2 percent.	Moderately well drained to imperfectly drained; friable silt loam subsoil; a black silty clay loam buried soil com-	Alluvium	1 to 3	Good to fair	Fair	A–7	ML–CL.

ıonly found below depths of to 4 feet is classified A–7–18+).						
y poorly drained; slightly rm silt loam subsoil over ightly firm silty clay loam; irly high organic-matter ontent to depths of 2 to 3 et.	Local alluvium	0 to 3	Good	Unsuitable	A–7 to peat or muck.	OH–Pt.
derately well drained; friable loam to sandy loam subsoil over friable loam to ndy loam.	Local alluvium	2 to 3	Good	Poor	A–6 or A–7	CL–OL.
se fibrous organic material depths of 18 to 48 inches ver firm silty clay loam.	Organic material over glacial drift.	0 to 3	Unsuitable	Unsuitable	Visual	Pt.
ently deposited sands and ndy loams.	Alluvium	0 to 3	Unsuitable	Fair	A–2 or A–3	SW–SP.
rly drained; firm clay loam silty clay subsoil over ightly firm loam or stratified nd and gravel at depths of to 4 feet.	Local alluvium	0 to 3	Fair to depth of dark surface layer.	Unsuitable	A–7 over A–1 or A–2.	CH–OH over GP–SW.
l drained; firm silty clay am to silty clay subsoil; ry firm silty clay shale elow depths of 18 to 36 ches.	Loess and glacial till over weathered shale.	3 to 5+	Fair to depth of dark surface layer.	Unsuitable	A–6 or A–7 over shale.	CL–CH over shale.
re than 40 inches of loose amy sand or sand on stream ottoms.	Alluvium	2½ to 3	Unsuitable	Fair	A–3 or A–2	SM–SP.
derately well drained to imperfectly drained; friable ndy loam subsoil; sandy am, loamy sand, or fine ravel below depths of about ½ feet.	Glacial outwash	2 to 3	Poor	Good	A–4 over A–1 or A–2.	SM–SC over SP–SW.
derately well drained; firm lty clay loam subsoil over iable silt loam.	Loess	5+	Good to depth of dark surface layer.	Fair	A–6 or A–7	ML–CL.
derately well drained; firm ay loam subsoil over slightly rm loam to clay loam; contains pebbles, stones, and me sand pockets.	Kansan glacial till	3 to 5+	Fair to depth of dark surface layer.	Fair	A–6 or A–7	SC–CL–CH.
ll drained; friable loam roughout; sand and gravel ockets common.	Cary glacial till	5+	Unsuitable	Good	A–4 to A–6	SC–CL.
erfectly drained; firm silty lay loam subsoil over friable lt loam.	Loess	3+	Poor	Poor	A–6 or A–7	CL–CH.
ll drained; firm silty clay am subsoil over friable silt oam.	Loess	5+	Good to depth of dark surface layer.	Fair	A–6 or A–7	ML–CL.
derately well drained; friable loam throughout.	Local alluvium	3+	Excellent	Poor	A–6 or A–7	CL–OL.
rly drained; firm silty clay ubsoil over firm silty clay; igh organic-matter content n top 1½ to 2 feet.	Alluvium	1 to 3	Poor	Unsuitable	A–7	OH–CH.
ll drained to excessively rained; friable loam subsoil; and or gravel below depths f 24 to 60 inches.	Glacial outwash	5+	Good to depth of dark surface layer.	Excellent	A–4 over A–1 or A–2.	SM–SC over SP–GW.

TABLE 6.—*Soil characteristics that effect engineering*—Continued

Soil series and miscellaneous land types	Slope	Brief description of soil profile and ground condition	Parent material	Depth to seasonally high water table	Suitability as source of—		Classification	
					Topsoil	Borrow for highway construction	AASHO [1]	Unified [2]
				Feet				
Webster	0 to 1 percent.	Poorly drained; firm silty clay loam subsoil over slightly firm loam; fairly high organic-matter content to depths of 1½ to 2 feet.	Cary glacial till	1½ to 3	Good to depth of dark surface layer.	Unsuitable	A–6 or A–7	CL–OH.

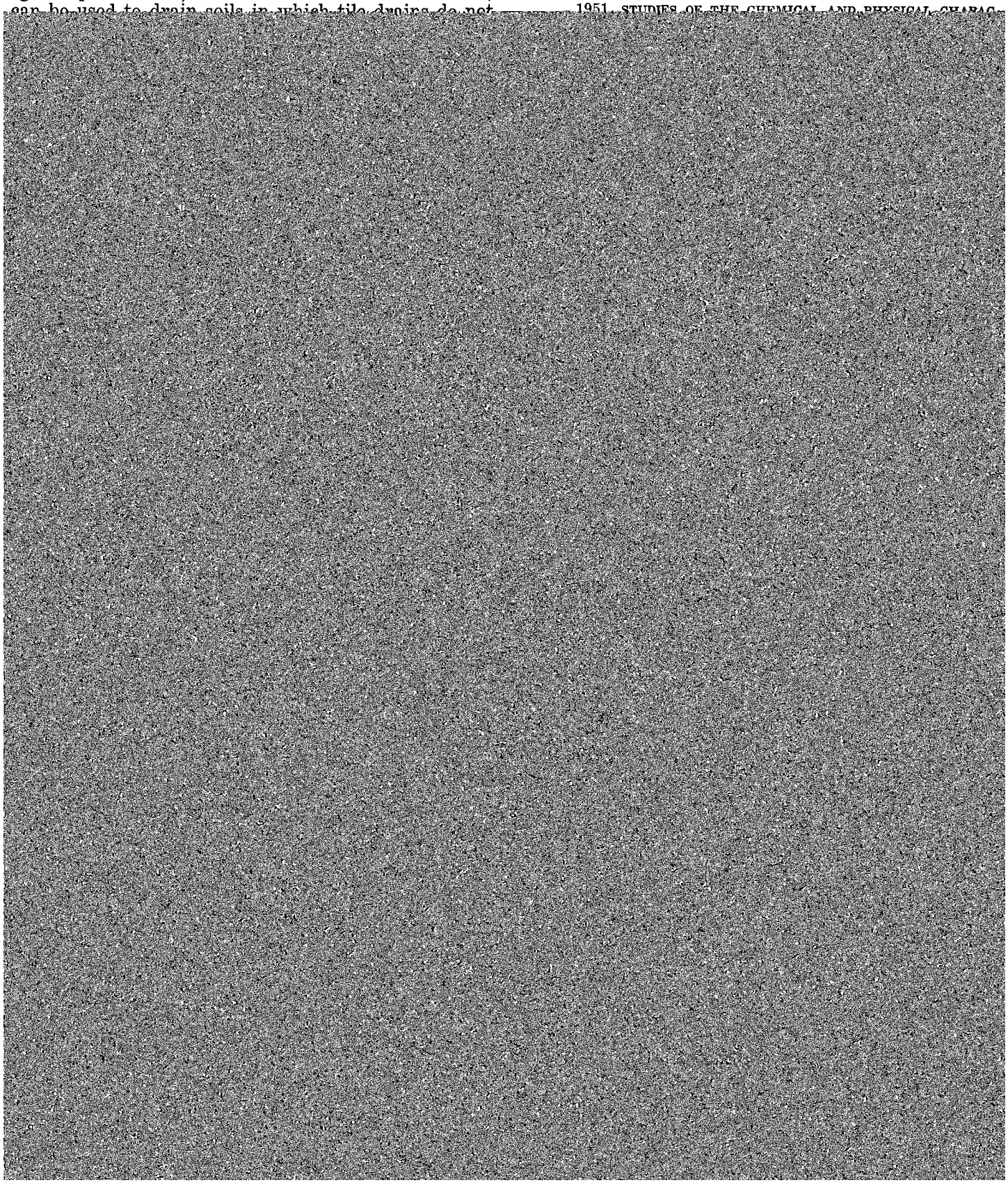
[1] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (pt. 1, ed. 7): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO Designation: M 145–49.

[2] Based on The Unified Soil Classification System, Tech. Memo. No. 3–357, v. 1, Waterways Experiment Station, Corps of Engineers, U. S. Army. March 1953.

[3] Wetness is due to sidehill seepage.

age. Open ditches, both crossable and noncrossable, can be used to drain soils in which tile drains do not

(4) HUTTON, CURTIS E.
1951. STUDIES OF THE CHEMICAL AND PHYSICAL CHARAC-

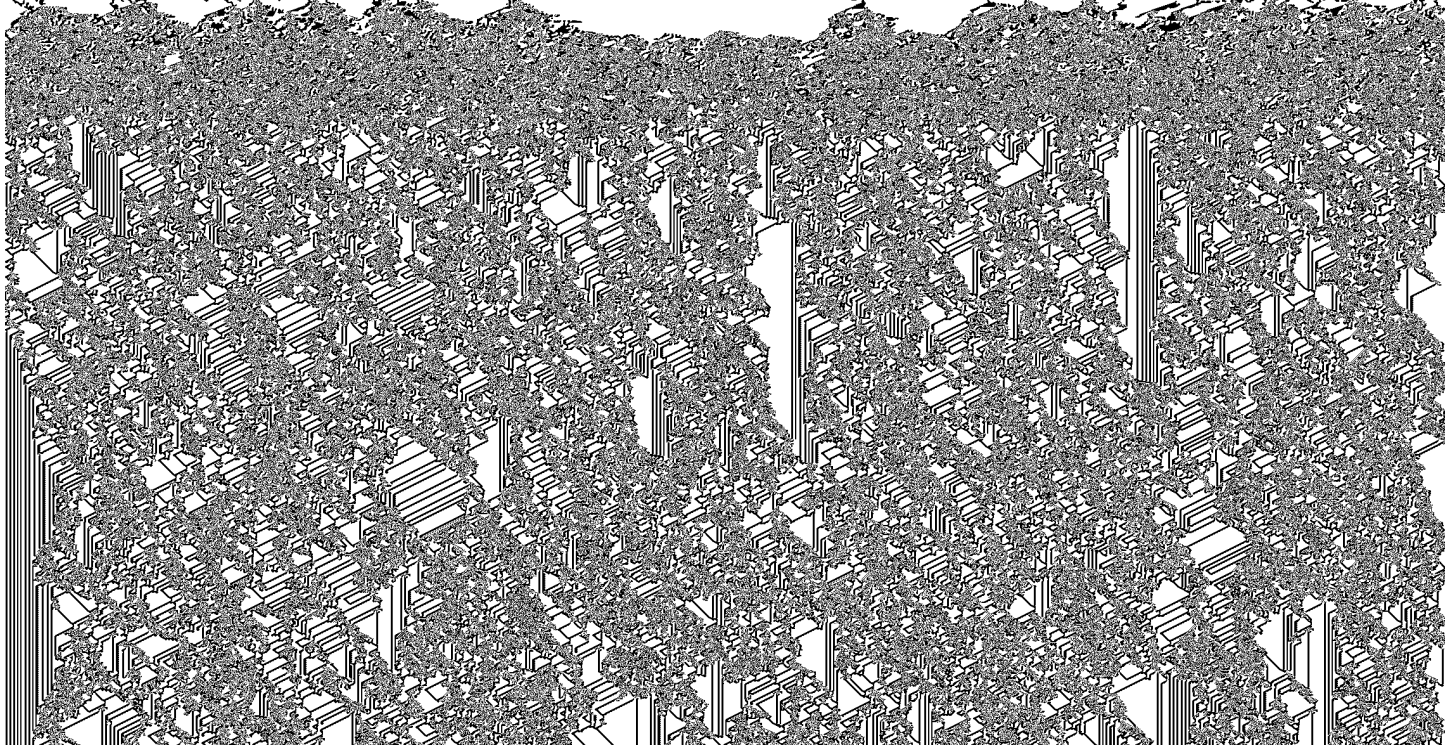


GUIDE TO MAP UNITS

[See table 4, p. 60, for management and estimated average acreage yields for cultivated soils, and table 2, p. 13, for approximate acreage and proportionate extent of soils. See pp. 85 to 93 for information on engineering properties of the soils.]

Map symbol	Capability subclass	Map unit	Page
Dg	I	Dorchester silt loam, deep over sand	26
DhA	I	Downs silt loam, 0 to 2 percent slopes	26
DhB	IIe	Downs silt loam, 2 to 5 percent slopes	26
DhC2	IIIe	Downs silt loam, 5 to 9 percent slopes, moderately eroded	26
DhD2	IIIe	Downs silt loam, 9 to 14 percent slopes, moderately eroded	26
DhE2	IVe	Downs silt loam, 14 to 20 percent slopes, moderately eroded	27
DhF2	VIIe	Downs silt loam, 20 to 30 percent slopes, moderately eroded	27
DkC3	IIIe	Downs soils, 5 to 9 percent slopes, severely eroded	27
DkD3	IVe	Downs soils, 9 to 14 percent slopes, severely eroded	27
DkE3	VIe	Downs soils, 14 to 20 percent slopes, severely eroded	27
FaB	IIs	Farrar fine sandy loam, 2 to 5 percent slopes	27
FaC	IIIs	Farrar fine sandy loam, 5 to 9 percent slopes	27
FaC2	IIIs	Farrar fine sandy loam, 5 to 9 percent slopes, moderately eroded	27
FaD2	IVs	Farrar fine sandy loam, 9 to 14 percent slopes, moderately eroded	27
FaE2	VIs	Farrar fine sandy loam, 14 to 20 percent slopes, moderately eroded	28
FaF2	VIIs	Farrar fine sandy loam, 20 to 30 percent slopes, moderately eroded	28
FbA	I	Fayette silt loam, 0 to 2 percent slopes	28
FbB	IIe	Fayette silt loam, 2 to 5 percent slopes	28
FbB2	IIe	Fayette silt loam, 2 to 5 percent slopes, moderately eroded	28
FbC2	IIIe	Fayette silt loam, 5 to 9 percent slopes, moderately eroded	28
FbD2	IIIe	Fayette silt loam, 9 to 14 percent slopes, moderately eroded	28
FbE2	IVe	Fayette silt loam, 14 to 20 percent slopes, moderately eroded	28
FbF2	VIIe	Fayette silt loam, 20 to 30 percent slopes, moderately eroded	28
FbG2	VIIe	Fayette silt loam, 30 to 40 percent slopes, moderately eroded	28
FcB	IIe	Fayette silt loam, bench position, 2 to	

Map symbol	Capability subclass	Map unit	Page
HaA2	IIIs	Hagener loamy fine sand, 0 to 2 percent slopes, moderately eroded	31
HaB	IIIs	Hagener loamy fine sand, 2 to 5 percent slopes	31
HaB2	IIIs	Hagener loamy fine sand, 2 to 5 percent slopes, moderately eroded	31
HaC	IIIs	Hagener loamy fine sand, 5 to 9 percent slopes	32
HaC2	IIIs	Hagener loamy fine sand, 5 to 9 percent slopes, moderately eroded	32
HaD2	VIs	Hagener loamy fine sand, 9 to 14 percent slopes, moderately eroded	32
HaD3	VIs	Hagener loamy fine sand, 9 to 14 percent slopes, severely eroded	32
HaE2	VIIs	Hagener loamy fine sand, 14 to 20 percent slopes, eroded	32
Hb	IIw	Harpster loam	32
HcA	I	Hayden loam, 0 to 2 percent slopes	33
HcB	IIe	Hayden loam, 2 to 5 percent slopes	33
HcB2	IIe	Hayden loam, 2 to 5 percent slopes, moderately eroded	33
HcC2	IIIe	Hayden loam, 5 to 9 percent slopes, moderately eroded	33
HcD2	IIIe	Hayden loam, 9 to 14 percent slopes, moderately eroded	33
HcE2	IVe	Hayden loam, 14 to 20 percent slopes, moderately eroded	33
HcF2	VIIe	Hayden loam, 20 to 30 percent slopes, moderately eroded	33
HcG2	VIIe	Hayden loam, 30 to 40 percent slopes, moderately eroded	33
Hd	IIs	Huntsville sandy loam	34
He	V	Huntsville sandy loam, channeled	34
Hf	I	Huntsville silt loam	33
Hg	V	Huntsville silt loam, channeled	33
IaC2	IIIe	Ida silt loam, 5 to 9 percent slopes, eroded	34
JaB	IIe	Judson silt loam, 2 to 5 percent slopes	34
JaC	IIIe	Judson silt loam, 5 to 9 percent slopes	35
KaA	IIs	Kato loam, moderately deep over sand and gravel, 1 to 3 percent slopes	35
KbA	I	Kato loam, deep over sand and gravel, 1 to 3 percent slopes	35
LaB	IIe	Ladoga silt loam, 2 to 5 percent slopes	35



Map symbol	Capability subclass	Map unit	Page
LeC2	IIIe	Lester loam, 5 to 9 percent slopes, moderately eroded	38
LeD2	IIIe	Lester loam, 9 to 14 percent slopes, moderately eroded	38
LeE2	IVe	Lester loam, 14 to 20 percent slopes, moderately eroded	38
LeF	VIIe	Lester loam, 20 to 40 percent slopes	38
LfC3	IIIe	Lester soils, 5 to 9 percent slopes, severely eroded	38
LfD3	IVe	Lester soils, 9 to 14 percent slopes, severely eroded	38
LgE	IVe	Lester-Colo complex, 0 to 20 percent slopes	38
LgF	VIIe	Lester-Colo complex, 0 to 40 percent slopes	38
LhA	I	LeSueur loam, 1 to 3 percent slopes	38
LkD2	IVe	Lindley loam, 9 to 14 percent slopes, moderately eroded	39
LkE2	VIe	Lindley loam, 14 to 20 percent slopes, moderately eroded	39
LmD3	VIe	Lindley soils, 9 to 14 percent slopes, severely eroded	39
LmE3	VIIe	Lindley soils, 14 to 20 percent slopes, severely eroded	39
LmF2	VIIe	Lindley soils, 20 to 40 percent slopes, moderately eroded	39
Ma	IIw	Marshan silty clay loam, moderately deep over sand and gravel	40
Mb	IIw	Marshan silty clay loam, deep over sand and gravel	40
Mc	IIIw	Muck, very shallow	40
Md	IIIw	Muck, moderately shallow	40
MeA	I	Muscatine silt loam, 1 to 3 percent slopes	41
NaA	I	Nicollet loam, 1 to 3 percent slopes	41
Nb	I	Nodaway silt loam	41
Oa	IIIw	Okoboji silt loam	42
ObB	IIe	Olmitz loam, 2 to 5 percent slopes	42
ObC	IIIe	Olmitz loam, 5 to 9 percent slopes	42
OcA	IIs	Olmitz sandy loam, 0 to 2 percent slopes	42
OcB	IIs	Olmitz sandy loam, 2 to 5 percent slopes	42
Pa	IIIw	Peat	42
Ra	VIIs	Riverwash	42
Rb	IIIw	Rolfe loam	43
Rc	IIIw	Rolfe loam, bench position	43
RdC2	IIIe	Runnells silt loam, 5 to 9 percent slopes, moderately eroded	43
RdD2	IVe	Runnells silt loam, 9 to 14 percent slopes, moderately eroded	44
RdE2	VIe	Runnells silt loam, 14 to 20 percent slopes, moderately eroded	44
RdF2	VIIe	Runnells silt loam, 20 to 40 percent slopes, moderately eroded	44
ReD3	IVe	Runnells soils, 9 to 14 percent slopes, severely eroded	44
Sa	IIIs	Sarpy loamy sand	44
SbA	IIs	Saylor fine sandy loam, 0 to 2 percent slopes	44
ScA	I	Sharpsburg silt loam, 0 to 2 percent slopes	45
ScB	IIe	Sharpsburg silt loam, 2 to 5 percent slopes	45
ScC	IIIe	Sharpsburg silt loam, 5 to 9 percent slopes	45
ScC2	IIIe	Sharpsburg silt loam, 5 to 9 percent slopes, moderately eroded	45
ScD2	IIIe	Sharpsburg silt loam, 9 to 14 percent slopes, moderately eroded	45
ScE2	IVe	Sharpsburg silt loam, 14 to 20 percent slopes, moderately eroded	45
SdD3	IVe	Sharpsburg soils, 9 to 14 percent slopes, severely eroded	45
SeC2	IIIe	Shelby loam, 5 to 9 percent slopes, moderately eroded	46
SeD2	IIIe	Shelby loam, 9 to 14 percent slopes, moderately eroded	46
SeE2	IVe	Shelby loam, 14 to 20 percent slopes, moderately eroded	46
SfE3	VIe	Shelby soils, 14 to 20 percent slopes, severely eroded	46
SfF3	VIIe	Shelby soils, 20 to 30 percent slopes, severely eroded	46
SgC	IIIe	Storden loam, 3 to 9 percent slopes	46
SgF2	VIIe	Storden loam, 20 to 40 percent slopes, moderately eroded	46
ShC3	IIIe	Storden soils, 5 to 9 percent slopes, severely eroded	46
ShD3	IIIe	Storden soils, 9 to 14 percent slopes, severely eroded	47
ShE3	IVe	Storden soils, 14 to 20 percent slopes, severely eroded	47
SkE	IVe	Storden-Colo complex, 0 to 20 percent slopes	47
SkF	VIIe	Storden-Colo complex, 0 to 40 percent slopes	47
SmC2	IIIs	Storden-Lakeville complex, 5 to 9 percent slopes, moderately eroded	47
SmD2	IVs	Storden-Lakeville complex, 9 to 14 percent slopes, moderately eroded	47
SmE2	VIs	Storden-Lakeville complex, 14 to 20 percent slopes, moderately eroded	47
Sn	I	Stronghurst silt loam	47
So	I	Stronghurst silt loam, bench position	48
TaA	I	Tama silt loam, 0 to 2 percent slopes	48
TaB	IIe	Tama silt loam, 2 to 5 percent slopes	48
TaB2	IIe	Tama silt loam, 2 to 5 percent slopes, moderately eroded	48
TaC	IIIe	Tama silt loam, 5 to 9 percent slopes	48
TaC2	IIIe	Tama silt loam, 5 to 9 percent slopes, moderately eroded	48
TaD2	IIIe	Tama silt loam, 9 to 14 percent slopes, moderately eroded	48
TbD3	IIIe	Tama soils, 9 to 14 percent slopes severely eroded	48
TcA	I	Terril loam, 0 to 2 percent slopes	49
TcB	IIe	Terril loam, 2 to 5 percent slopes	49
TcC	IIIe	Terril loam, 5 to 9 percent slopes	49
Wa	IIIw	Wabash silt loam	49
Wb	IIIw	Wabash silty clay	49
Wc	IIw	Wabash-Gravity-Nodaway complex	50
WdA	IIs	Waukegan loam, moderately deep over sand and gravel, 0 to 2 percent slopes	50
WdB	IIs	Waukegan loam, moderately deep over sand and gravel, 2 to 5 percent slopes	50
WdC	IIIs	Waukegan loam, moderately deep over sand and gravel, 5 to 9 percent slopes	50
WeA	I	Waukegan loam, deep over sand and gravel, 0 to 2 percent slopes	50
WeB	IIe	Waukegan loam, deep over sand and gravel, 2 to 5 percent slopes	50
WeC	IIIe	Waukegan loam, deep over sand and gravel, 5 to 9 percent slopes	51
Wf	IIw	Webster silty clay loam	51
Wg	IIw	Webster silty clay loam, calcareous variant	51

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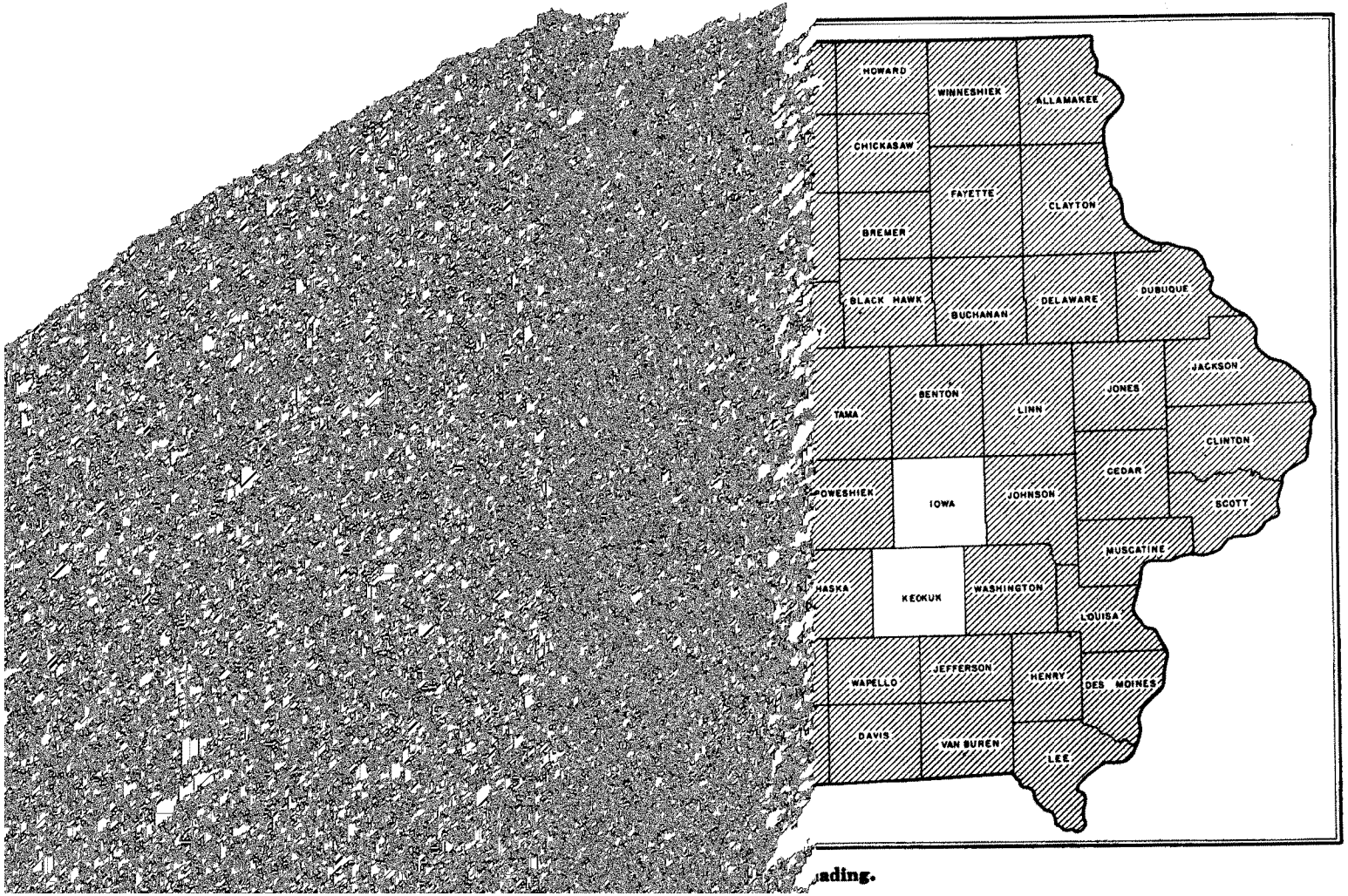
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